CLAVIS HOROLOGIÆ;

OR,

A KEY

To the whole Art of ARITHMETICAL DYALLING,

In Two Parts.

The First shewing how to draw the Hour-Lines on all manner of Regular Dyals, and how to reduce all Irregular Dyals into Regular Forms by means of a new Latitude and new Declination, and that Arithmetically.

The Second Part sheweth how to place all manner of Furniture on all sorts of Dyals, let them be never so irregular, and that Arithmetically; whereunto is annexed the Tables of the Altitude of the Sun for every hour of the Day at his Entrance into the 12 Signs from one Degree of Latitude to 90; with Tables of Azimuth to each Latitude, and for every hour of the Day at his Entrance into each Sign, with many other Tables useful in the Art of Shadows.

Whereunto is Annexed an

APPENDIX,

BEING

The Explication of the Pyramidical Dyal set up in His Majesties Garden at *White-Hall*, 1669. In which very many sorts of Dyals are contained; By which, besides the hours of all Kinds diversly expressed, many things relating to *Geography*, *Astrology* and *Astronomy*, are by the Suns shadow made visible to the Eye, by that Reverend Father *Francis Hall*, alias *Line*, of the Society of *Jesus*, Professor of the Mathematicks at *Liege* in *Germany*.

By *JOHN HOLWELL*, Teacher of the Mathematicks.

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Philipp Leece THE Philip Leece Booke

EPISTLE TO THE READER.

Courteous Reader,

LET not my bold Attempt make thee have any ill Thoughts of me, becauſe I have preſumed to preſent unto the World this ſmall Piece of *Dyalling*, ſeeing ſo many Men have done their Endeavour in the like kind; among which Authors I have made bold to follow the Method of Mr. *Wells* in his *Art of Shadows*, in the Firſt Part thereof; but in the Second, I have beſtowed the pains of calculating Tables of the Altitude of the Sun at his Entrance into every of the twelve Signs, for every hour of the Day from one Degree of Latitude to 90; as alſo Tables of Azimuths for each

Table of Altitude, with the Uſe of them in the placing of the Furniture on all manner of Dyals; and I have preſented you with the Deſcription of the Dyal that was ſet up in the King's Garden in the Year 1669. by that eminent Mathematician Father *Francis Hall*, alias *Line*, of the Society of Jeſus at *Liege* in *Germany*: Beſides, I have preſented you with three ways how to deſcribe any Furniture on any Plain that doth depend on the declination, without having reſpect to the hour-lines; the which I had from my very good Friend *Edmond Halley* of of *Queens Colledge* of *Oxford*. I ſhall ſay nothing in commendation of this Book, hoping it will ſpeak for it ſelf; but ſhall ſubſcribe my ſelf

A Lover of all thoſe whoſe Inclinations leads them to the Mathematicks, ſo long as my Name is

JOHN HOLWELL.

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CHAP.

CHAP. I.

Of the Making of the Fundamental Diagram.

THE Making of this Scheme is thus; Take 60 Deg. from your Line of Chords, and upon Z, as a Circle, deſcribe the Circle NESW; croſs it at right Angles in Z, with the Lines NZS, and EZW: That done, ſeek the Place of the Pole at P; thus the natural Tangent of ; the diſtance of the Pole from the Zenith being placed from Z, to P. gives the Point of the Pole, and the Natural Tangent of half the Latitude of the Place being placed from Z to K, will alſo give the Point in the Meridian-Circle, where the Æquator doth touch; Now foraſmuch as the Tropick of *Cancer* is diſtant from the Zenith 28 *d.* 2 *m.* the natural Tangent of half that 28 *d.* 2 *m.* which is 14 *d.* 1 *m.* being placed from Z to *t*, gives the Point *t*; the Tropick of *Capricorn*, being 75 *d.* 2 *m.* diſtant from the Zenith, the natural Tangent of half that 75 *d.* 2 *m.* which is 37 *d.* 31 *m.* being placed from Z to F, gives the Point F for the Tropick of *Capricorn*. And foraſmuch as the Circle NOS reclines from the Zenith 43 *d.* the Tangent of half that 40 *d.* being placed from Z to O, gives the Point O for the Reclination; Likewiſe the prick'd Circle DAG doth recline from the Zenith 35 *d.* now if you take the natural Tangent of half that 35 *d.* which is 17 *d.* 30 *m.* and place it from Z to A, gives the Point A for the Reclination.

Having found theſe Points, by which the forementioned Circles do paſs, you may find the Centers after this manner:

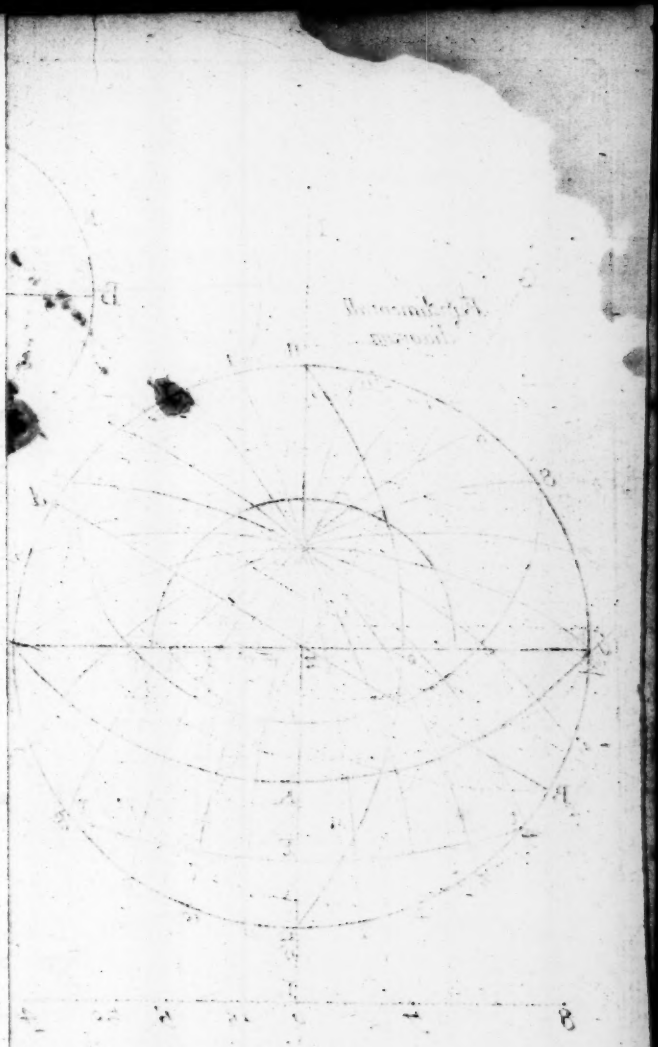
Firſt, For the Center of the Circle W P E, the Point P being found by the foregoing Rules, take the Secant of the Compl. of the diſtance of the Pole from the Zenith, and place it from P to L, and the Point L, will be the Center of the Circle WPE. Then for the Center of the Circle W K E, foraſmuch as the Point K is diſtant 51 *d.* 32 *m.* from the Zenith, take this 51 *d.* 32 *m.* from 90 *d.* then the natural Secant of the remainer being placed from K, towards N, and it will touch the Point *d*, which is the Center of the Circle WKE; then for the Center of the Circle N *t r*, the Point *t* is diſtant from the Zenith Z 28 *d.* 2 *m.* Now half

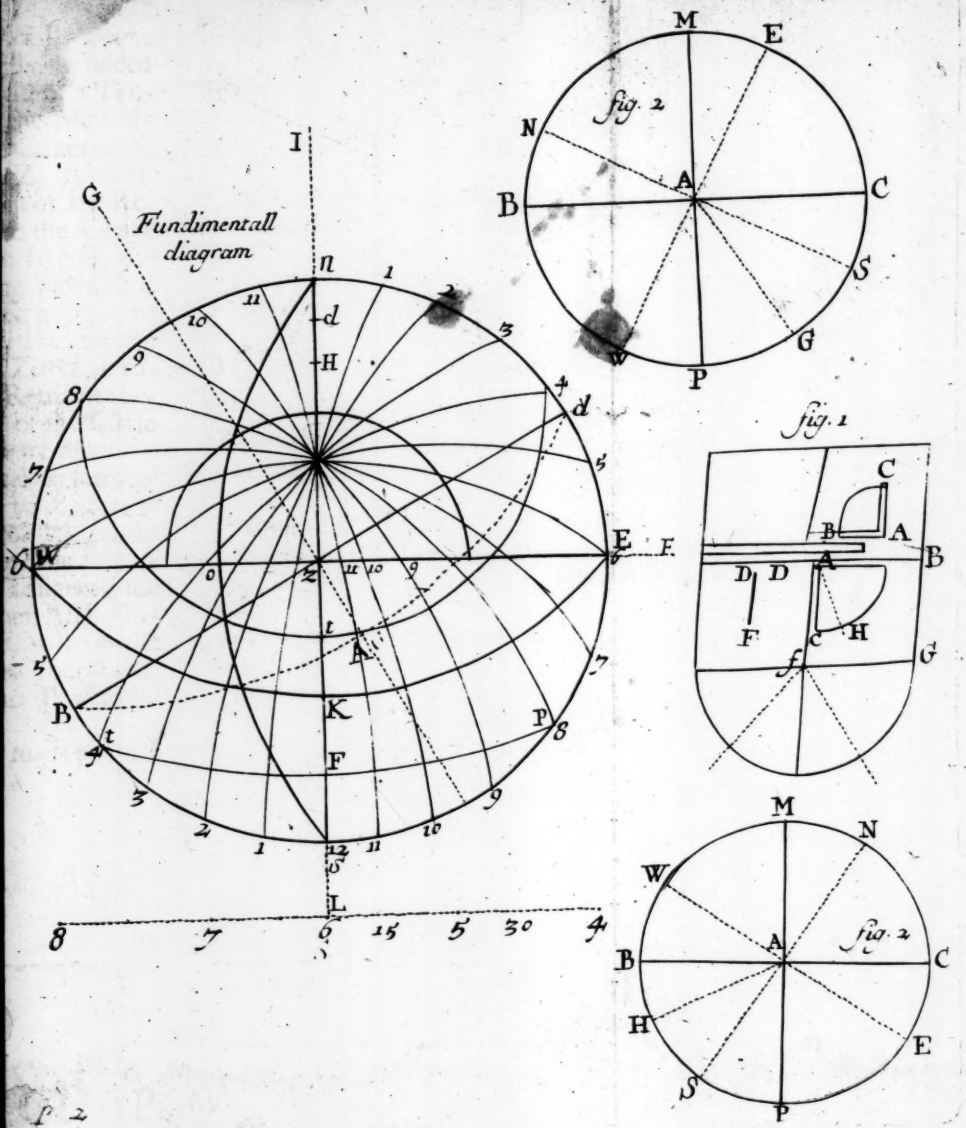
this 28 *d.* 2 *m.* which is 14 *d.* 1 *m.* being added unto 90 *d.* will amount to 104 *d.* half thereof is 52 *d.* The natural Tangent thereof being added unto the natural Tangent of 14 *d.* 1 *m.* half that Sum will be a Tangent, which being placed from *t*, towards N, will fall in the Point H: this Point H is the Center of the Circle N *t r*; then for the Center of the Circle *t* F P, the Point F being diſtant from the Zenith Z, 75 *d.* 2 *m.* this 75 *d.* 2 *m.* being ſubſtracted from 90 *d.* the natural Secant of the Remainer, being placed from N to I, gives the Point I, which is the Center of the Circle *t* F P; then for the Center of the prickt Arch D A G, the Point A reclining from the Zenith 35 *d.* This 35 *d.* being ſubſtracted from 90 *d.* the natural Secant of the Remainer being placed from A to *g*, the Point *g* will be the Center of the Circle D A G; then for the Center of the Circle N O S, O doth recline from the Zenith 40 *d.* This 40 *d.* being ſubſtracted from 90 *d.* the Secant of the Remainer being placed from O to F, the Point *f* will be the Center of the Circle N O S. Then for the Center of the Hour-Circles; which are thus:

Firſt, Seek the Center of the Six of the Clock Hour-Circle as formerly directed; whoſe Diſtance is from P. to L, will always be the Secant of the Latitude of the Place, making Z F. the Radius croſs P L, at L. with a Line drawn at right Angles thereto; which let be the Line L. 5 : 4 7 : 8. Then making P L. the Radius, 8 L 4 will be a Tangent-Line thereto; then the natural Tangent of the Equinoctial Hour-Arches being placed from L. unto 5 4, one way, and 7 8 the other, will be the Center of each reſpective Circle: thus; Set one Point of your Compaſſes in the Point 4, and the other being extended unto P, deſcribe the Arch 4 P 4. and ſo for all the reſt of the Hour Circles.

The Circles of the Diagram being thus deſcribed and made plain, I ſhall now come to the Art of Dyalling it ſelf.

CHAP.




Fundimentall diagram
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fig. 2
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fig. 2
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p 2

CHAP. II.

Containing the Diſtinction of Dyals; *with the Manner of finding the Declination, Reclination and Inclination of all Planes whatſoever.*

IT is firſt to be underſtood, that all great Circles of the Sphere being projected upon a Plane howſoever ſituated, become ſtraight Lines; as is very well Demonſtrated by *Clavius* in the 11th. *Chap.* of his Firſt Book of *Gnomonices*: From whence it followeth, That the Hour-Lines of every Dyal being great Circles of the Sphere drawn upon any Regular Flat, will become ſtraight Lines alſo.

Now the Art of Dyalling doth conſiſt in the Artificial finding out theſe Lines, and their Diſtance each from other; which continually vary according to the ſituation of the Plane on which they are projected; Likewiſe that part of the Style that ſhews the Hour, ought to lie parallel with the Axis of the World; by which means the very End of the Style points to one of the Poles of the World.

Dyals (*according to* Clavis) *are diſtinguiſhed into Seventeen Kinds; as followeth.*

1. The Horizontal being parallel to the Horizon.
2. The North and South direct; by ſome called a Vertical Dyal, becauſe parallel to the Prime vertical, or Circle of Eaſt and Weſt.
3. South direct reclining, leſs than the Pole.
4. North inclining, more than the Pole.
5. South direct inclining, leſs than the Æquator.
6. North reclining more than the Æquator.
7. South direct reclining, or North-inclining to the Pole, called a direct Polar Plane, becauſe parallel thereto.
8. South direct inclining, or North reclining to the Æquator, called an Æquinoctial Plane, becauſe parallel thereto.
9. South and North declining Eaſt or Weſt.
10. Eaſt or Weſt direct.
11. Eaſt or Weſt direct reclining or inclining.

12. A { South / North } Plane declining East or West { Inclining / Reclining } To the Pole, called a Polar Decliner.

13. A { South / North } Plane, declining East or West. { Inclining / Reclining } To the Æquator, called an Æquinoctial Decliner.

14. A { South / North } Plane, declining East or West. { Reclining / Inclining } Of which there are two ſorts, the one paſſing above, the other below the Pole.

16. A { South / North } Plane, declining East or West, { Reclining. / Inclining. } Whereof are two ſorts, the one paſſing above, the other below the Æquinoctial.

Before you can contrive the Hour-Lines upon theſe ſeveral Planes, there are certain Arches of great Circles; in number ſix: which muſt of neceſſity be known; and divers of thoſe are in ſome caſes given, and in others they are ſought.

1. The Firſt is an Arch of a great Circle perpendicular to the Plane, comprehended between the Zenith and the Plane, which is the Reclination thereof.
2. The Second is an Arch of the Horizon between the Meridian and Azimuth, paſſing by the Pole of the Plane, which is the Declination thereof.
3. The Third is an Arch between the Meridian and the Horizon, preſcribing the Diſtance of the Twelve a Clock Hour from the Horizontal Line.
4. The Fourth is an Arch of the Plane between the Meridian and the Sub-ſtyle, which limits the Diſtance thereof from 12.
5. The Fifth is, An Arch of a great Circle, perpendicular to the Plane, comprehended between the Pole of the World and the Plane called the heighth of the Style.
6. The laſt is an Angle at the Pole of the World between the two Meridians, the one of the Place, the other of the Plane, the Sub-ſtyle of all Dyals being the Meridian of the Plane, commonly called the Planes Difference of Longitude.

The two firſt of theſe Arches is always given, or may be found by the Rules following:

Firſt,

First, *For the Reclination and Inclination of any Plane.* Fig. 1.

If the Plane ſeem to be level with the Horizon, you may try it by laying a Ruler thereupon, and applying the ſide of your Quadrant A B, to the upper ſide of the Ruler, ſo that the Center may hang a little over the end of the Ruler, and holding up a Thred and Plummet, ſo that it may play upon the Center, if it ſhall fall directly upon the Level Line A C, making no Angle therewith, it is an Horizontal Plane.

If the Plane ſeem to be vertical, like the Wall of an upright Building, you may try it by holding the Quadrant, ſo that the Thred may fall on the Plumb-Line A C; for then if the ſide of the Quadrant ſhall lie cloſe to to the Plane, it is erect, and a Line drawn by that ſide of the Quadrant, ſhall be a Vertical Line, as the Line D E, in the Figure. If the Plane ſhall be found to incline to the Horizon, you may find out the quantity of the Inclination after this manner;

Apply the ſide of your Quadrant A C to the Plane, ſo ſhall the Thred upon the Limb give you the Inclination required.

Suppoſe the Plane B G E D, and the Line D E, to be Vertical, to which applying the ſide of your Quadrant A C, the Thred upon the Limb ſhall make the Angle C A H, the Inclination required; whoſe Complement is the Reclination.

To find the Declination of a Plane.

To effect this, there are required two Obſervations; the firſt, of the Horizontal Diſtance of the Sun from the Pole of the Plane; the Second, is of the Suns Altitude, thereby to get the Azimuth: And theſe two Obſervations muſt be made at one inſtant of time as near as may be, that the parts of the Work may the better agree together.

Firſt, For the Horizontal Diſtance of the Pole of the Plane, apply one edge of the Quadrant to the Plane, ſo that the other may be perpendicular to it, and the Limb may be towards the Sun, and hold the whole Quadrant Horizontal as near as you can conjecture; then holding a Thred and Plummet at full Liberty, ſo that the Shadow of the Thred may paſs through the Center and Limb of the Quadrant, obſerve what Degrees of the Limb the Shadow cuts, counting them from that ſide of the Quadrant which is perpendicular to the Horizontal Line, thoſe Degrees are call'd the Horizontal Diſtance.

Secondly,

Secondly, At the ſame inſtant obſerve the Suns Altitude; by this Altitude you may get the Suns Azimuth from the South; which ſhall be taught hereafter.

When you make your Obſervation of the Suns horizontal Diſtance, mark whether the Shadow of the Thred fall between the South and the perpendicular ſide of the Quadrant or not: For,

1. If the Shadow fall between them, then the Diſtance and Azimuth added together, do make the Declination of the Plane; and in this caſe the Declination is upon the ſame Coaſt whereon the Suns Azimuth is.

2. If the Shadow fall not between them, then the difference of the Diſtance and Azimuth is the declination of the Plane; and if the Azimuth be the greater of the two, then the Plane declineth to the ſame coaſt whereon the Azimuth is; but if the Diſtance be the greater, then the Plane declineth to the contrary, to that whereon the Suns Azimuth is.

Note here further, That the Declination ſo found, is always accounted from the South, and that all Declinations are numbred from North or South towards Eaſt or Weſt, and muſt not exceed 90 Degrees.

1. If therefore the number of Declination exceed 90 deg. you muſt take its Complement to 180 deg. and the ſame ſhall be the Planes Declination from the North.

2. If the Declination found, exceed 180 deg. gives the Planes Declination from the North, towards that Coaſt whereon the Sun is.

By this accounting from North and South, you may always make your Planes Declination not to exceed a Quadrant or 90 deg. and as when it declines nothing, it is a full South or North Plane, ſo if it declines juſt 90 deg. it is then a full Eaſt or Weſt Plane.

Theſe Precepts are ſufficient to find the Declination of any Plane howſoever ſituated: But that there may be no Miſtake, we will add an Example.

Example 1. *Fig.* 2.

Let the Horizontal Diſtance from the Pole of the Planes horizontal Line, repreſented in *Fig.* 2. by R Z. the Line of Shadow be 24 deg. deſcribe the Circle B C M P, which ſhall repreſent the Horizontal Circle, and draw the Diameter B A C. repreſenting the horizontal Line of the Plane, and the Diameter M P, repreſenting the Poles of the Planes horizontal Line; then by a Line of Chords ſet off your horizontal diſtance 24 deg. found by obſervation in the Afternoon from

P to

P to G, and from G to S; ſet of the Suns Azimuth 40 deg. ſo ſhall the point S repreſent the South, N the North, E the Eaſt, and W the Weſt.

Now becauſe the Line of Shadow A G falleth between P, the Pole of the Planes horizontal Line, and S, the South-point; therefore according to the former direction, I add the horizontal Diſtance P G. 24 deg. to the Suns Azimuth G S. 40 deg. and their Aggregate is P S. 64 deg. the declination ſought; and in this caſe it is upon the ſame coaſt with the Sun; that is Weſt, according to the Rule given; and as the Figure it ſelf ſheweth the Eaſt and North-points being hid from our ſight by the Plane it ſelf, this therefore is a South-Plane declining Weſt 64 deg.

Example 2.

Let the horizontal Diſtance taken in the Afternoon by obſervation, be 67 deg. and the Suns Azimuth from the South 43 deg. be given; then draw as before the Circle B C M P; and from P to H, ſet off the horizontal diſtance 67 deg. from H, to S, the Suns Azimuth 42 deg. Now then becauſe the South-point doth fall between P, the Pole of the Planes horizontal Line and H, and the horizontal diſtance, I deduct the Suns Azimuth H S, 42 deg. from H P. the horizontal diſtance, and their difference is S P. 25 deg. the declination ſought; and becauſe the horizontal diſtance is greater than the Azimuth; therefore the declination is contrary to the coaſt of the Sun; then is a South-plane declning Eaſt 25 degrees.

How to find the Suns Azimuth by his Altitude.

Take the Complement of the Suns declination to 90 deg. and that will be the ſide A B in *Fig.* 4. and the Complement of the Latitude of the Place will be the ſide B C; and the Complement of the Altitude to 90 deg. will be the ſide A C; then the Angle at C will be the Azimuth; which may be found according to *Caſe* 11. of Oblique Spherical Triangles; as you may ſee in my *Trigonometry*.

As for Example.

Let the Suns Altitude be 40 deg. and the Latitude of the Place be 47 deg. and the Suns declination be 16 deg. North.

Note,

Note, That whereas you are to ſubſtract the Suns declination from 90 deg. it is at no time but when the Sun hath North declination; but if he hath South, you muſt add the Suns declination to 90 deg. and their Sum will be the ſide A B in *Fig.* 4.

	d.			
The Complement of the Suns declinat. is-	74			
The Complement of the Suns Altitude is--	50			
The Complement of the Latitude———	43			
Their Sum is———	167	*m.*		*Sines.*
The half Sum is———	83.	30.	*Co.Ar.*	0002801
The Difference of the Baſe and half Sum—	9.	30.	*Co.Ar.*	0782391
			Adde	
The Diff. of the ſide A C, and half Sum—	33.	30	——	9741889
The Diff. of the ſide B C, and half Sum——	40.	30	——	9812544
The Sum of theſe Sines is———				20339625
The half Sum of theſe Sines is the Tangent of an Arch.———				10169812

Which being doubled gives the Azimuth required.

How to find a Meridian Line upon an Horizontal Plane.

If your Plane be level with your Horizon, draw thereon the Circle B C M P; then holding a Thred and Plummet, ſo as the Shadow thereof may fall upon the Center, and draw the Line of Shadow H A; then if the Suns Azimuth ſhall be 50 deg. and the Line of Shadow taken in the Afternoon, ſet off the 50 deg. from H to S. and the Line S N ſhall be the Meridian Line deſired.

CHAP.

CHAP. III. *The First Dyal.*

To draw the Hour-Lines in an Æquinoctial Plane.

AN Æquinoctial Plane is that which lies parallel to the Æquator, and is an Horizontal Plane under the Pole. The making of this Dyal is very easie; for it is no more but to describe a Circle with 60 of your Line of Chords, and therein to draw both the Diameters crossing each other at right Angles; the Circle may be as large as the Plane will allow; then divide this Circle into 24 equal parts or hours, which you may subdivide into halves and quarters: That being done, set up a streight Pin perpendicular to the Plane in the Center of the Circle; every hour is 15 deg. the half hour 7 deg. 30 min, and the quarter 3 deg. 45 min.

This Dyal being set in a Frame to be elevated to any Latitude, may be of very good Use for Sea-men when they are at Sea, to find the time of the day,

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CHAP. IV. *The Second Dyal.*

To draw the Hour-Lines upon a Polar Plane.

A Polar Plane is that which doth lie parallel to the Axis of the Poles, and is an horizontal Dyal in those places that lie under the Æquator.

The Hour-Lines in a direct polar plane, must be all drawn parallel to the Hour-Line of 12. The Style must either be a streight Pin or Needle set upright, or a Wyer made to lie parallel to the plane, and must stand over the Hour-Line of 12.

You may proportion the height of your Style according to the length of your plane, and what hour-lines you would have to fall upon the plane.

The length of the plane may be taken in Inches or parts of Inches, reckoning the Inch to be divided into 10, or 100 equal parts: Then for the height of the Style, say,

As the Tangent of the Hour-Line 4 or 5, is to the Log. of their Distance from the Meridian in Inches and Parts,
So is the Radius to the height of the Style, and Inches and Parts.

Then for the Hour-Lines;

As the Radius is to the Log. of the Styles height in parts of Inches,
So is the Tangent of any Hour-Line to the Log. of the Distance thereof from the Meridian-Line.

Example.

Let there be a polar plane, whose length is 12 Inches, and that it were required to put on all the hour-lines from 7 in the Morning unto 5 in the Afternoon, here you will have 5 hours and 6 Inches on either side of the Meridian-line: Before you can work the Operation, you must turn your hours into degrees, by allowing for every hour 15 deg. so will you have 75 deg. for the 5 hours; then turn the Inches into Parts, by allowing 100 parts to every Inch; so will you have 600 parts.

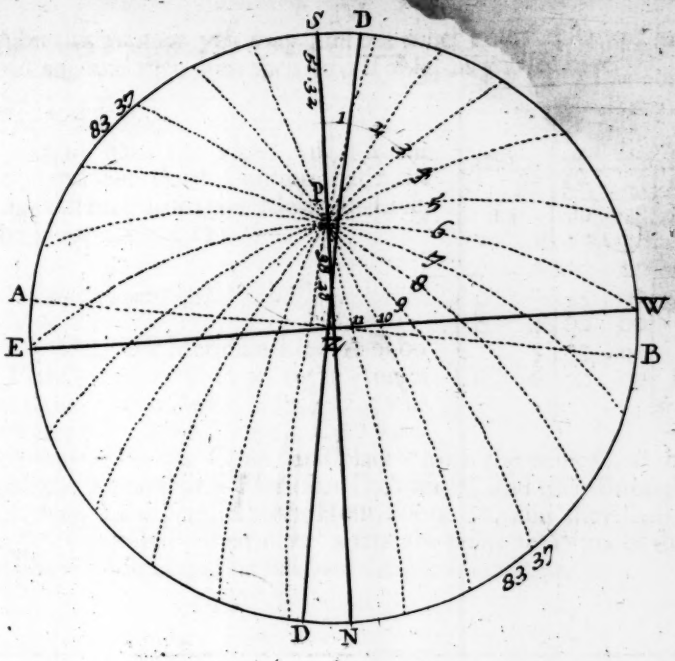
Then for the Styles Height:

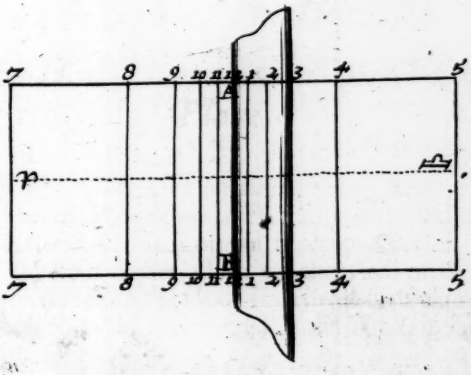
As the Tangent of 5 hours (*viz.*) 75 *d. Co. Ar.*		9428053	Adde
is to the Log. of the distance from the Meridian	600 parts,	2778151	Adde
So is the Radius		10000000	Adde
To the Log. of the Styles height in 161 parts,		22206204	
that is 1 Inch and 61 parts of an Inch.			

For the Hour-Lines Distance from the Meridian.

As the Radius	90*d.*	10000000	Adde
is to the Log. of the height of the Style	161*p.*	22206204	Adde
So is the Tangent of 15 *d.* for one hour	15*d.*	9428052	Adde
to the Log. of the first hours distance from the Meridian	43*p.*	11634256	

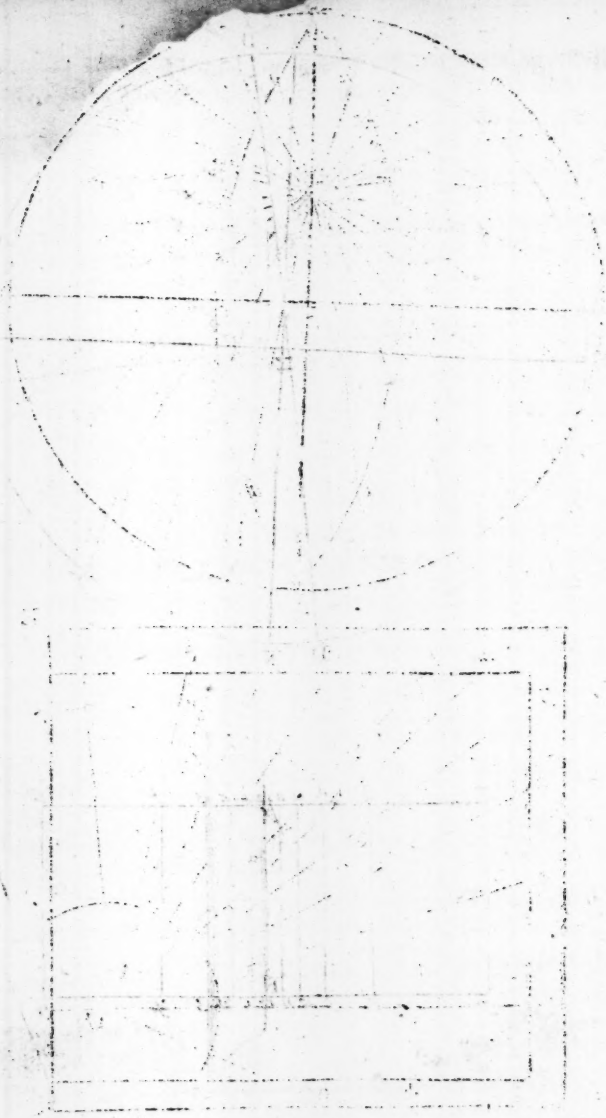
After





Dyal. 2

1. Polar plane



After this manner you may find the other hours distances from the Meridian, and then draw them in a Table, as you see here.

Hours.		Angles at Pole.		Tangent in part.	
H	H	G	M		
12		00	00	00	00
11	1	15	00	00	43
10	2	30	00	00	63
9	3	45	00	1	61
8	4	60	00	2	79
7	5	75	00	6	00
6	6	90	00	*Infinit.*	

The first Column hath the Hours, and the second hath the Hour-Angle at the Pole, and the third Column hath the Hours distance from the Meridian-Line, or the Hour-Line of 12.

The Geometrical Projection.

First, Draw the Meridian-Line AB on the Plane, and cross it at right Angles with the Line *Aries*, *Libra*, which Line will be the Equator; then take off these parts which you find in the Table, and place it from the point C, at the crossing of the Equator and Meridian both ways; and then through these points draw Lines parallel to the Hour-line of 12, and they shall be the hour-lines required; then place a straight point or Wyer of the same length as you found it to be just over the Meridian-Line.

CHAP. V. *The Third Dyal.*

To draw the Hour-Lines upon a Direct East or West Plane.

THis Plane by some is called a Meridian plane, because it lieth parallel to the Meridian Circle in the Fundamental Diagram; and forasmuch as the Meridian-Circle is one of the hour-Circles, and no plane lying in any of the hour-circles, doth cut the Axis of the World, but is parallel thereto; therefore the Hour-lines in all such planes are parallel each to other, and may be represented in the Fundamental Diagram, after this manner;

Let NESW in this case be supposed to be the Equator divided into 24 equal parts, and let the pricked line E 8 7 parallel to NZS, be a Tangent-line to that Circle in E, streight Lines drawn from the Center Z

through the equal Divisions of the Limb intersecting the Tangent-line, shall give points in 4 5 6, 7 8 9 10 11; through which Parallels being drawn to the prime Vertical, or 6 a clock hour-line EZW, you have the hour-lines desired; which may for the more certainty's sake, be found by Tangents also: for if you make ZE the Semi-diameter or radius of the Circle NESW, then will the line E 8 7 be a Tangent-line thereto, and the Tangent of 15 degrees, and 30 45 60 75 deg. being set both ways from E, will give the distance of the hour-lines 5 and 7, 8 4 9 and 3, &c. from the 6 a clock hour, as aforesaid.

Now the height of the Style may be found according to the bigness of the plane, and the distance of the hour-line from each other; as was taught in the last Dyal, and may be gathered into a Table, as you see following.

Hours. East.		Angles at Pole. D	M	Tangent Inch	P	Hours. West.
4		30	00	5	77	8
	½	22	30	4	14	
5		15	00	2	68	7
	½	7	30	1	32	
6	6	*Substile.*		00	00	6
	½	7	30	1	32	
7		15	00	2	68	5
	½	22	30	4	14	
8		30	00	5	77	4
	½	37	30	7	67	
9		45	00	10	00	3
	½	52	30	13	3	
10		60	00	17	32	2
	½	67	30	24	14	
11		75	00	37	32	1
	½	82	30	75	96	
12		*Infinite.*		*Infinite.*		

The Geometrical Projection.

First, From the lower corner on the North-side of the plane, draw the Horizontal Line A B, then take 60 deg. from off your Line of Chords, setting one foot of your Compasses in the point A, with the other describe the prickt Arch C D, and thereon set off the compl. of the Lat. of the place, which will be the point D, for the Lat. of 51 *d.* 32 *m.* Then from A, through D, draw the Line A D E; which line will be the Equator of the Dyal; then chuse a point in this Line to be the hour of 6; and at this point cross the line A D E in the point E, at right angles with the same; then from the point E set off the several Tangents, as you find in the Table, and they will give the several points for the hours; which hour-lines must be drawn parallel unto that Line that crosseth the Equator A D E (*viz.*) E 6: 6. The Style may be a streight pin, and must stand upon the hour-line of 6, or the point E, and the length of the Style must be equal to the hour-line of 3 or 9 in either Dyal.

CHAP.

CHAP. VI. *The Fourth Dyal.*

To draw the Hour-Lines upon A Horizontal Plane.

THis Plane is by some called a Vertical plane; because the Pole of the plane points to the Vertex and Nadir; but the plane it self doth lie parallel to the Horizon, from whence it hath its Name: there is but one only Arch required (which is the Arch between the pole of the World and the plane it self, for the artificial finding the hour-distance) which is the height of the pole above the Horizon (equal to the height of the Style) always given; by the help of which, you may find the hour-distances from each other, by Calculation.

This Plane is represented in the Fundamental Diagram, by the outward Circle N E S W, in which the Diameter S N doth represent the Meridian Circle; Z doth represent the Zenith; P for the pole of the World; and the Circles drawn through P for the hour-circles of 1 2 3 4, *&c.* as they are numbred from the Meridian, and limit the distance of each hour-line from the Meridian, upon the plane, according to the Arches of the Horizon N 11, N 10, N 9, *&c.* Which by the several Triangles N P 11, N P 10, N P 9, may thus be found; In the Triangle N P 11, you have first the side P N always given (it being the Latitude of the place, or the height of the pole above the Horizon) and the Angle at P, is given one hours distance from the Meridian; whose measure in the Equator is 15 deg. which I shall call the Angle at the Pole, and the right Angles N, to find the Arch N 11, by the 5th. Case of *Right Angled Spherical Triangles.*

As the Radius———————————	N 90 00	10;000000
Is to the Sine of the height of the Style———	N P 51 32	9;9893725
So is the Tangent of the Angle at the Pole———	15	9;428052
To the Tangent of the Hour Arch———	N 11 11 51	19321777

Of which is the distance of 1 and 11 from the Meridian-line N. After this manner may you find the rest of the Hour-Arches, and place them, as in the Table;

The

Hours.		Lat. 51 32 Angle at Pole.		Hour-Arches.	
∞	∞	G	M	G	M
12		∞	∞	∞	∞
11	1	15	∞	11	50
10	2	30	∞	24	20
9	3	45	∞	38	3
8	4	60	∞	53	35
7	5	75	∞	71	6
6	6	90	∞	90	∞

The Geometrical Projection.

First, Draw the Line 6 C 6, to repreſent the hour-line of 6; then draw the perpendicular C 12 at right Angles with the hour-line of 6; then take 60*d.* off your Line of Chords, and ſetting one foot of your Compaſſes in the point C (which is the Center of your Dyal) and with the other deſcribe the prickt Arch 6 E 6; then take from off the ſame line of Chords that you ſtruck your Arch with, the ſeveral hour-Arches, as you find in the Table, and place them on both ſides the hour-line of 12 upon that Arch, and draw lines from the Center C, through thoſe ſeveral pricks, and they will ſhew the hour-lines required, thus;

Take off 11 *d.* 50 *m.* from your line of Chords, and place it from E (the place where the Meridian cuts the Circle) both ways, and thoſe two points will be the hours of 11 and 1; then through thoſe two pricks draw lines from the Center; then take from off your line of Chords 24 *d.* 20 *m.* the meaſure of the Arch belonging unto 10 and 2, and place it from E both ways, ſo ſhall you have the pricks in the Arch for 10 and 2 of the Clock; then from the Center draw lines through the pricks, and it will be the hour-lines of 10 and 2. After this manner you muſt proceed until you have ſet off all the reſt of the hour-lines unto 6. Then for the other hours on the other ſide of the Center, do thus; Draw the line of 7 in the Morning, quite through the Center, and that part of the line that is on the other ſide of the Center, will be the hour-line of 7 at night. Do ſo by 8 in the Morning, and you will have the hour-line of 8 at Night. Then extend the hour-line of 5 at Night, quite through the Center, and it will be the hour-line of 5 in the Morning. Do ſo by the hour-line of 4 in the Afternoon, and that will give you the hour-line of 4 in the Morning. Having thus drawn the hour-lines, take from the ſame line of Chords the quantity of the height of your Style, and place it from E to O, and draw the prick C O, repreſenting the Axis of the World, or the height of the Style above the plane, from any part of the Meridian-line C 12, draw a line parallel unto the hour-line of 6 C 6, as is B A, it ſhall make a Triangle, the fitteſt form to ſupport the Style at the true height, let the triangular Style C B A be

be erected at right Angles with the Meridian-line, or 12 of the Clock hour-line, and then is your Dyal perfected.

Note, This Horizontal Dyal muſt be ſo placed, that the very end or Tip of the Style points directly to the North-pole, which may be done by finding a Meridian-line upon the plane; then place the hour-line of 12 upon the Meridian-line, and you will have your deſire.

Now for the finding of the Meridian-line on any Horizontal plane, take this general way.

For the finding of the Meridian-Line.

Firſt draw many concentrick Circles upon the Horizontal plane; then in the Center of all theſe Circles ſtick up a Pin or Needle perpendicular to the Horizon, and at a conſiderable time before noon, mind what Circle the very Tip of the Shadow doth touch; and where it toucheth the Circle, make a Mark; then mind in the Afternoon when the Shadow of the Pin or Needle doth touch the ſame Circle, and there make a Mark; then find the middle between theſe two Marks, and there make another Mark; a line drawn from the Center through this Mark laſt made, ſhall be a true Meridian-line.

CHAP. VII. *The Fifth Dyal.*

To draw the Hour-line on a Direct South or North-Plane.

THis Plane by ſome is called a Vertical plane, becauſe the plane it ſelf doth lie parallel to the prime Vertical Circle, and in the Fundamental Diagram it is repreſented by the Line E Z W; and therefore it cutteth the Meridian of the place at right Angles in the Zenith, and hath the two poles of the plane ſeated in the North and South (from whence this Dyal hath its name) Interſection of the Meridian and Horizon; and becauſe the plane hideth the North-Pole from our ſight, we may therefore conclude this for a general Rule, That every plane hath that pole raiſed or depreſſed above it, which lieth open unto it: Therefore this plane hath the South-Pole elevated, and the Style muſt point downwards.

Suppoſe

Suppoſe then that P, in the Fundamental Diagram benow the South-Pole, and N, the South-part of the Meridian, and S, the North; then do all the hour-circles from the Pole, cut the Line E Z W, repreſenting the plane unequally, as the hour-lines will do upon the plane it ſelf, and as it doth appear by the Figures ſet at the end of every hour-line in the Dyal.

Now having already the Poles Elevation given, as was in the Horizontal, there is nothing elſe to be found, but the true hour-diſtances upon the Line E Z W, from the Meridian S Z N.

Note, the hour-lines being of an equal diſtance on both ſides of the Meridian, are equal upon the Plane alſo; half being found therefore, the other half is found alſo; and therefore you may begin on which ſide you will.

In the Triangle Z P 11, right angled at Z, you will have Z P given the Complement of the Latitude of the Place 38 *d.* 28 *m.* the which is alſo the height of the Style to this Dyal, and the Angle at P 15 deg. one hours diſtance from the Meridian upon the Equator, to find the ſide Z 11; for which the proportion as before.

	d.	*m.*		
As the Radius	90	00	10000000	
Is to the Sine of the Styles height	38	28	9793863	Add
So is the Tangent of the Angle at the Pole	15	00	9428052	
So the Tangent of the Hour-Arch on the plane	9	32	9221915	

Which is Z 11 : 9 *d.* 32 *m.* After this manner muſt you find the reſt of the Hour-Arches, and gather them in a Table as you did the Horizontal one.

The Geometrical Projection of this Dyal is the very ſame with the Horizontal one; and therefore needleſs for me to repeat the ſame things over again.

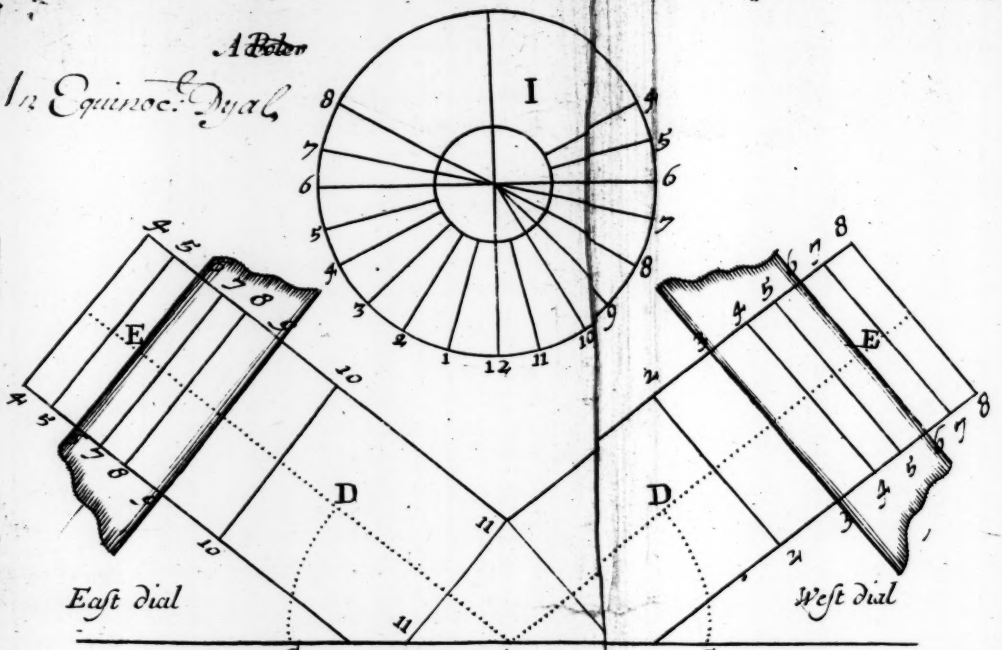
The North-plane is but the backſide of the South, lying in the ſame Azimuth with it; and therefore whatever hath been ſaid of the South-plane, may be applied unto the North.

Therefore it is no more but the turning of the South-Dyal upſide down, and leave but all the ſuperfluous between 5 and 7, and 4 and 8. and the Dyal to the North-plane is made to your hand; only note, the Center of the Dyal muſt ſtand next the Horizon, and the end of the Style muſt point to the North-Pole.

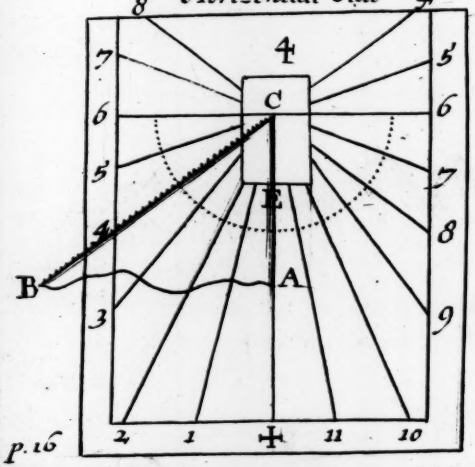
CHAP.

A Polar

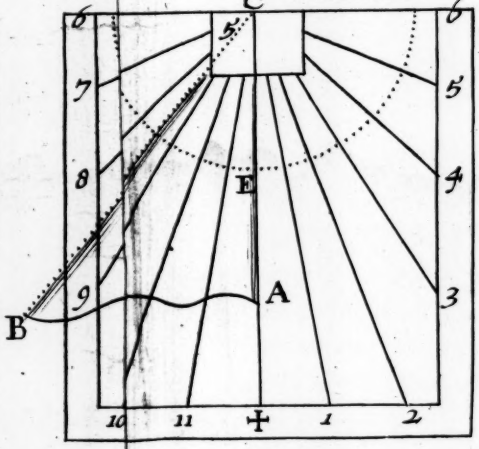
In Equinoc: Dyal



Horizontall dial



South dial



CHAP. VIII. *The Sixth Dyal.*

To draw the Hour-lines on a South or North-inclining or reclining Dyal.

ALL thoſe Dyals that have their Horizontal Line lying Eaſt and Weſt, are in that reſpect ſaid to be South or North; if they be alſo upright, and paſs through the Zenith, they are direct Verticals; if they recline to the Pole of the World, they are direct polar planes; if the plane inclines to the Equator, they are Equinoctial planes, and are all of them deſcribed before; if the Plane inclines or reclines to none of theſe points, they are called then by the Name of South Incliners or Recliners.

Theſe Planes have alſo two Faces, one to the Zenith, and the other to the Nadir; the one being an Incliner, and the other a Recliner. Theſe Planes are upright South and North Planes in one Latitude or other.

Now for the finding of the Latitude in which theſe Planes ſtand upright, obſerve theſe Rules following:

1. For South-Incliners; if the Inclination be leſs than the Latitude of the place, ſubſtract the Inclination out of the Latitude of the place, and what remains will be the Latitude of the place wherein this Plane ſtands upright.

2. If the planes Inclination be more than the Latitude of the place, ſubſtract the Lat. of the place out of the Inclination, and the Remainer will be the Latitude of the place.

3. If the Planes Reclination be leſs than the Complement of the Latitude of the place, add the Planes Reclination unto the Latitude of the place, and their Sum will be the Latitude of the place; and the South-pole is elevated above the plane. If the planes Reclination be more than the Compl. of the Lat. of the place, ſubſtract the Complement of the Lat. out of the Reclination, and the remainer will be the Complement of the new Latitude, where it ſtands as an upright Dyal, and the North-pole is elivated above the plane.

Note, The North-Incliners are the ſame with the South Recliners; and the South Incliners are the ſame with the North Recliners; they being only the backſide to each other, as the North-Dyal was to the South.

The making of theſe kind of Dyals are the ſame with the South in all reſpects, the height of the Style, being the Complement of the Latitude of the place wherein it ſtands as an upright Dyal; therefore I ſhall forbear to give any further Directions concerning them, they being ſo eaſie.

CHAP. IX. *The Seventh Dyal.*

How to draw the Hour-lines upon a South or North Erect Plane Declining Eaſt or Weſt to any Declination.

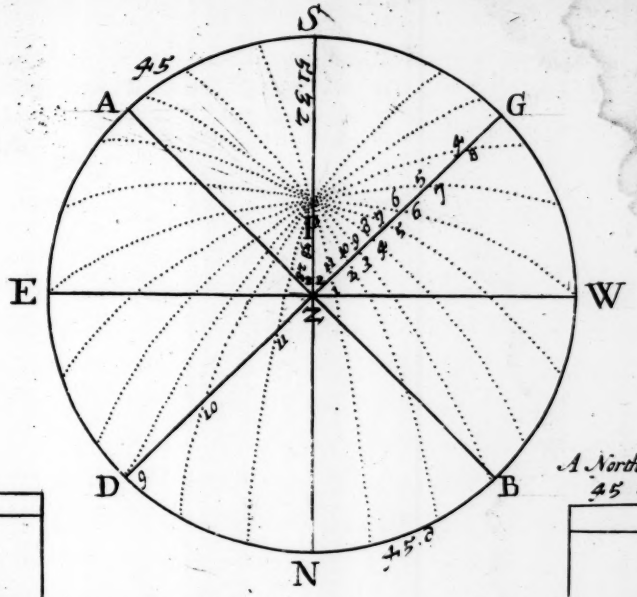
EVery Erect Plane lieth under ſome Azimuth or other; and thoſe only are ſaid to decline, which differ from the Meridian and prime Vertical. Theſe Planes are Erect South-Planes in that Latitude whoſe Complement is equal to the height of the Style, and that lieth ſo far to the Eaſtward of the place wherein it ſtands as a Decliner, as is the Planes difference of Longitude, if the Plane declines Eaſt; or ſo much to the Weſtward, if the Plane declines Weſt; for the Subſtile of all Declining Dyals doth repreſent the Meridian of the place wherein it ſtands, as a full South-Dyal: Becauſe I would not have you confuſed with too many Lines, I have drawn a Diagram for each Dyal; and in the Diagram, *Fig.* 4. let S E N W repreſent the Horizon; S P Z N the Meridian thereof; S, the South-part, and N, the North; E Z W the Azimuth of Eaſt and Weſt; D Z G, the Declining Plane; the Poles thereof are A and B; the Declination S B, and N B; A, declining from S, toward the Eaſt 45 deg, and B declines from N, the North part of the Meridian the ſame degrees, their Poles being oppoſite, the Hour-Circles are thoſe that meet at the Pole P; and croſs the Plane G Z D unequal; and note, where you ſee the Hour-Circles run neareſt together, thereabouts muſt the Subſtile ſtand contrary to the Coaſt of Declination, becauſe the Sun when he riſeth in the Eaſt, doth caſt his Shadow to the Weſtward.

There be five things to be conſidered before you come to the drawing of the Hour-lines (*viz.*) Two given and Three required.

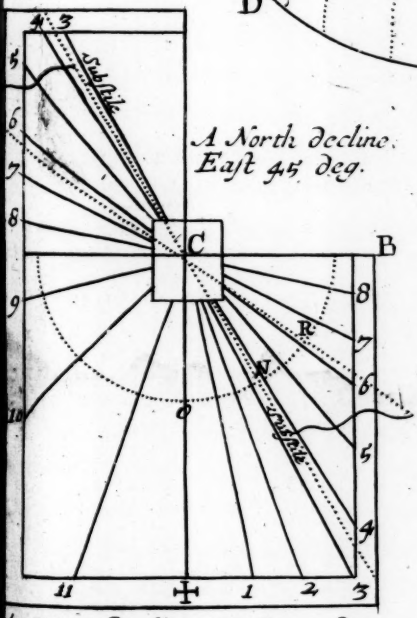
The Things given are,

S P, the Latitude of the Place, 51 *d.* 32. *m.*
S A, the Planes Declination Eaſt, 45 *d.* 00 *m.* } Given.

The

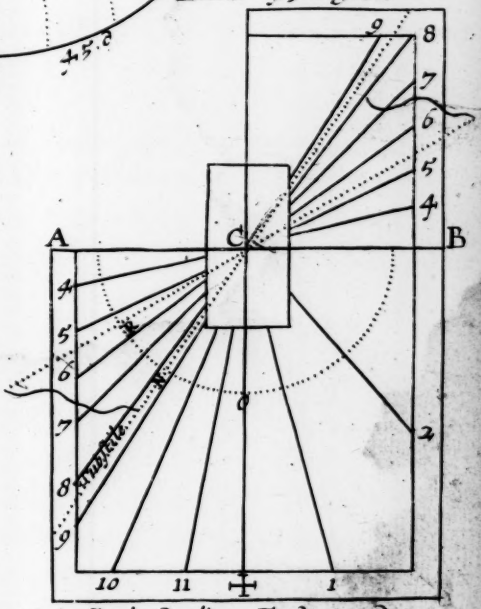


A North decline East 45 deg.



A South decling West 45 deg.

A North decling West 45 degrees



A South decling East 45 deg.

	d.	m.		
The Height of the Style above the Plane P R,	26	6		
The Diſtance of the Subſtyle from the Meridian Z R.	29	20		Required.
The Planes Difference of Longitude, commonly called the Angles between the Meridians R P Z,	51	57		

The Subſtyle of all declining Planes being the Meridian of the place wherein it ſtands, as a full South-Dyal, muſt neceſſarily be part of a great Circle paſſing through the Pole of the World, and croſs it the plane at right Angles; therefore in the right angled Triangle P R Z, right angled at R: but as yet the place of R is not found, you have firſt given the Baſe P Z, 38 *d.* 28 *m.* the Complement of the Latitude of the place, and the Angle P Z R, the Complement of the Planes Declination, and the right Angle R, to find the Side P R, the Styles height aforeſaid:

Therefore by the ſecond Caſe of right Angled Spherical Triangles, thus;

	d.	m.		
As the Radius ——— R	90	00	10000000	
Is to the Sine of the Compl. of the Lat. — P Z	38	28	9793831	
So is the Sine of the Compl. of the Planes Declination P Z R ———	45		9849485	Add
To the Sine of the Styles Height P R ———	26	6	29643316	

Secondly, You may find the Diſtance of R from Z, which is the Subſtyle-Diſtance from the Meridian, by the firſt Caſe of Right Angled Spherical Triangles, after this manner;

	d.	m.		
As the Cotangent of the Compl. of the Lat. of the Plane P Z, ———	38	28	*Co. Ar.* 9990087	
Is to the Radius ——— R, ———	90		10000000	
So is the Coſine of the Compl. of the Planes Declination P Z R, ———	45		9849485	Add
To the Tangent of ——— Z R, ———	29	20	29749572	

The Subſtyles Diſtance from the Meridian, or 12 of the Clock hour-Line, the ſame things being given to find the Planes Diff. of Longitude, which is the Angle at P, between the two Meridians, may be found by the Third Caſe of Right Angled Spherical Triangles, thus;

	d.	m.	
As the Co-tang. of the Compl. of the Planes Declination P Z R,	45	00	10000000
Is to the Radius	90	00	10000000
So is the Co-ſine of the Compl. of the Lat. of the Place P Z,	38	28	9893745 Add
To the Co-tangent of the Planes Diff. of Longitude Z P Z,	51	57	= 9893745

Having found the Planes Diff. of Longitude from the Place, which is 51 *d.* 57 *m.* doth ſhew the Subſtyle to fall between the 8 and 9 of the Clock, 9 being 45 deg. from the Meridian, and 8 of the Clock 60 deg. diſtant; therefore let fall a Perpendicular between 9 and 8, to inform the Fancy in the reſt of the Work, whith is the Point R. The next thing that muſt be done, is to frame a Table of Hour-Angles at the Pole; thus;

Begin at the 12 of the Clock Hour that is ſet down the Planes Difference of Longitude againſt 12, and then from that ſubſtract 15 deg. and that will be for 11 of the Clock: Then from that Angle that ſtands againſt 11 of the Clock, ſubſtract 15 deg. and the Remainer ſet againſt 10 of the Clock; then from the Number that ſtands againſt 10, ſubſtract 15 deg. and ſet the Remainer againſt 9 of the Clock; then if you find the Remainer to be leſs than 15 deg. then ſubſtract that Number that ſtands againſt 9, out of 15 deg. and ſet the Remainer againſt 8 of the Clock; then by the continual Addition of 15 deg. you will have the Numbers againſt the reſt of the Hours: as you will ſee in the following Table.

The

	d.	m.
The Lat. of the place.	51	32
The Dec. of the Plane.	45	00
Height of the Style.	26	6
Dist. of the Subst. from the Merid.	29	21
Diff. of the Mer.	51	57

The East Decliner.				The West Decliner.			
Hours.	Angles at Pole.		Hour-Arches.	Hours.	Angles at Pole.		Hour-Arches
3	83	3	74 31	10	81	57	72 27
4	68	3	47 31	11	66	57	45 58
5	53	3	30 20	12	51	57	29 21
6	38	3	19 1	1	36	57	18 19
7	23	3	10 37	2	21	57	10 3
8	8	3	3 34	3	6	57	2 26
Substyle.	Substyle.		Substyle.	Substyle.			Substyle.
9	6	57	2 26	4	8	3	3 34
10	21	57	10 3	5	23	3	10 37
11	36	57	18 19	6	31	3	19 1
12	51	57	29 21	7	53	3	30 20
1	66	57	45 58	8	68	3	47 31
2	81	57	72 27	9	83	3	74 31

Having thus prepared the Table, I return unto the last Diagram; wherein you have the right Angled Spherical Triangle 9 P R, to resolve therein P R, is the given Height of the Style above the Plane (*viz.*) 26, 6, and the Angle 9 P R given, as before 6, 57, and the right Angle at R, to find the Side 9 R; then by the 16 Case of Right Angled Spherical Triangles, Thus;

	d.	m.		
As the Radius	90	00	10000000	} Add
Is to the Sine of the Styles height	26	7	9643329	
So is the Tangent of the Hour-Angle	6	57	9085999	
To the Tangent of the Hour-Arch	2	26	8729328	

After this manner were all the Hour Arches found in the Table; there being no variety in all the rest of the Work, but only changing the Hour-Angle at the Pole according to every Hours distance from the Substyle; therefore it is needless to reiterate the same: Therefore transcribe into a piece of Paper the Sine of the height of the Pole P R, which is 26, 7; the Sine thereof is 9643329; for that being continually added unto the Tangent of every hour-distance in the Equator from the Substyle, doth beget new Tangents of the hour-Arches, as you see them placed in the Table.

The

The Geometrical Projection,

Having calculated the Hour-distances, you may draw the Dyal: First, Draw the Horizontal Line A C B, then cross it at right Angles with the Line C O 12, in the Point C; then take 60 deg. from a line of Chords, making C the Center, draw the Semicircle A O B, representing the Azimuth G Z D in the last Diagram, in which the Plane lieth upon the Circle, from O to N; set off the distance of the Substyle from the Meridian, which was found before to be 29, 21, upon the West-side of the Meridian, because the Plane declines East; then take from off the same line of Chords the several hour-distances as they are calculated in the foregoing Table (*viz.*) 10 *d.* 37 *m.* for 7 and 5 a Clock 18 *d.* 19 *m.* for 11 and 1 of the Clock, and so of the rest; and set them both ways from the Substyle upon the Circle R N O, as the Table it self directeth: draw straight lines from the Center C, to these several Points, so have you the true hour-lines which were desired. Lastly, Take from off the same Chord the height of the Style found to be 26 *d.* 6 *m.* which being set from N to R, and a straight line drawn from C through R, representing the Axis or Style of the Dyal, then the Dyal is finished for use.

When you apply this Dyal unto any Wall or Plane, let the line A C B be horizontal, and C O perpendicular, and the Side or Axis of the Style C R, pointing to the South-pole in South-Dyals, and to the North-Pole in North-Dyals, erected at right Angles over the Substyle line C N; so have you fitted a Dyal for any South-plane declining 45 deg. Easterly; you have not only this Dyal, but you have made three more besides; that is, four in all (*viz.*) a South Decliner West as much, and a North Declining East and West as much, only placing the Numbers of the hours and the Style representatively upon each Plane.

Now to make this plainly appear out of the former Diagram; Suppose that S were again the North part of the Horizon, and P the North-Pole, and that G Z D were a North declining plane 45 deg. West as much as the Pole A is from S, then do all the Hour-Circles cross the same place as did the former; only D 2 Z, which was in the former on the East-side, and Afternoon hours, will now be D 10 Z, the West side, and Forenoon hours, will now be (in the West Decliners) between 3 and 4 of the Afternoon hours; and lest there should be yet any doubt conceived, I have drawn all the four Dyals aforesaid; wherein you may

may plainly ſee that there is no difference at all between the South declining Eaſt, and the South declining Weſt; but that the Forenoon hours on the left hand of the Meridian in the Eaſt Dyal, are become the Afternoon hours on the right hand of the Meridian in the Weſt Dyal, and on the left in the Eaſt; the Style alſo of neceſſity changing the place with the hours, for the Reaſons aforeſaid.

And here you may alſo obſerve, each North Dyal framed out of the correſpondent South, only drawing the hour-lines of the South Dyal through the Center-Style, and all (*viz.*) the N E. out of the S W. and the N W. out of the S E. Suppoſing B C D drawn out of the S W. Dyal to be placed upon the N E. ſide of the Plane, and B C D drawn out of the S E. Dyal, to be placed on the N W. ſide of the plane, according to the true Nature and Declination of each Plane; therefore it muſt of neceſſity follow, that the South-ſide of the Plane declining Weſt, the North-ſide thereof declining as much Eaſt, and the South-ſide of the Plane declining Eaſt, the North-ſide thereof declineth as much Weſt; and this alſo will hold true in the reſt of the Lineaments belonging to each Dyal.

There is one thing more to be noted, naturally ariſing out of this Diagram, which few other will afford (*viz.*) all the four Dyals being ready drawn, it is a good Argument to prove the Analogy of them (interchangeably) for the South declining Eaſt, and the North declining Weſt, are repreſented by the Line G Z D. Suppoſing the one ſide of it according to the height of the Pole A and B, to repreſent the North, and the other ſide the South, as before: And in the very ſame manner imagine B Z A, to be the declining Plane, and G D, the Poles thereof; then have you S G, a South declining Weſt, and N D, a North declining Eaſt 45 deg. and the prickt hour-Circles with the very ſame Angles croſſing the Plane B Z A; as formerly the black-lin'd Circles did G Z D; for the Hour-Circles falling from P, upon G Z D, in the South declining Eaſt, and North declining Weſt; as alſo upon B Z A, in the South declining Weſt, and North declining Eaſt, have like and equal interſection; as by the bare inſpection of the Diagram appears.

From theſe Reaſons I conclude all theſe kind of Dyals to be but one. And note in the Table I have ſet the Hours of Eaſt and Weſt declining together, that it may ſerve for both turns; ſeeing the Hour-Arches upon the Plane, have the ſame Angles and Diſtances in both.

Now foraſmuch as theſe kind of Dyals are of all others moſt commonly uſed, I have been the larger upon them; the more, becauſe I

ſhall

ſhall reduce all Inclining or Reclining Declining Dyals to upright Declining ones, by finding the New Latitude and New Declination; whererein it ſtands as an upright Dyal.

CHAP. X. *The Eighth Dyal.*

How to draw the Hour-Lines upon any Plane Declining far Eaſt or Weſt, or any other in which the Hour-Lines run cloſe together, by help of two Equinoctial lines, without reſpect to the Center.

BEfore I paſs from Declining Planes, I think it fit to ſhew the making of thoſe Dyals, which by reaſon of their great Declination, have ſo ſmall Elevation of the Style, that the Hour-Lines running cloſe together, are of little Uſe without ſome other help; ſuch are many both Recliners, and declining Recliners; but chiefly all thoſe that decline Eaſt or Weſt 80 deg. and upwards, in which ſome of the Hour-Lines are but few Minutes aſunder, and the nearer the Declination is to 90 deg. the narrower are the Hour-Lines; as by the Scheme it ſelf, and this Example following will more plainly appear. To remedy this, the ordinary way is with a Beam-Compaſs of 16, 18, or 20 foot long, upon a large Floor to draw the Dyal, and then to cut off the hours Style, and all at 10, 12 or 14 foot diſtance from the Center, as will beſt fit the Plane; but this being too Mechanical for them that have any Trigonometrical Skill, I omit, and rather commend the way following; by help whereof, you may upon half a Sheet of Paper, make a perfect Model of your Dyal, to what greatneſs you think fit, without regard at all to the Center.

The Demonſtration.

Suppoſe therefore the Wall or Plane DZD, on which you would make a Dyal, declineth from S. to A, that is from South Eaſterly 83 *d.* 37 *m.* having drawn the Scheme by the Rules agreeable to this Declination

tion (as you see done in this Example) set down the *Data*, and by them seek the *Quæsita*.

		d.	m.
Data	Elevation of the Pole P S	51	32.
	Declination S A. South Easterly,	83	37
Quæsita	1. Height of the Style P R	3	58
	2. Dist. of the Substyle and Meridian Z R	38	18
	3. Angles of the Meridian Z P R	85	00

And you shall find the height of the Pole or Style P R, above the Plane, to be 3 *d.* 58 *m.* by the Second Case of Right Angled Spherical Triangles, the Substyle from the Meridian Z R, to be 38 *d.* 18 *m.* by the First Case of Right Angled Spherical Triangles; and the Angle between the Meridians Z P R, to be 85 *d.* next hand, by the Third Case of Right Angled Spherical Triangles; which Angle shews, that if the Substyle were drawn at the distance of 38 *d.* 18 *m.* from the Meridian, it would fall within 5 *d.* of 6 of the Clock, upon the Equator, crossing the Substyle at right Angles.

The first Table for 83 d. 37 m.			
Hours and Parts.	Equinoctial Distances.	the true hour-distance.	Natural Tangents.
	d. m.	d. m.	
4 —	35 — 00	2 — 46	0483
4 ½	27 — 30	2 — 4	0361
5 —	20 — 00	1 — 27	0253
5 ½	12 — 30	0 — 53	0154
6 —	5 — 00	0 — 21	0061
6 ½	2 — 30	0 — 10	0029
7 —	10 — 00	0 — 42	0122
7 ½	17 — 30	1 — 15	0218
8 —	25 — 00	1 — 51	0323
8 ½	32 — 30	2 — 31	0439
9 —	40 — 00	3 — 19	0579
9 ½	47 — 30	4 — 19	0755
10 —	55 — 00	5 — 38	0986
10 ½	62 — 30	7 — 34	1328
11 —	70 — 00	10 — 45	1899
½	77 — 30	17 — 20	3121
12 —	85 — 00	38 — 19	7902

The Second Table of 83 d. 37 m.		
Hours and Parts.	Equinoctial Distances.	Natural Tang.
	d. m.	
4 — 8	35 — 00	700
½	27 — 30	520
5 — 7	20 — 00	364
½	12 — 30	221
6 — 6	5 — 00	087
½	Substyle. 2 — 30	044
7 — 5	10 — 00	176
½	17 — 30	315
8 — 4	25 — 00	466
½	32 — 30	637
9 — 3	40 — 00	839
½	47 — 30	1091
10 — 2	55 — 00	1428
½	62 — 30	1921
11 — 1	70 — 00	2747
½	77 — 30	4511
12 — 12	85 — 00	11430

The

The Arithmetical Calculation.

Now therefore make a Table of hours and halves, if you think good, according to the first Table; wherein every hours true distance and part is calculated by the Rules of the former Chapter, and necessary, if you work from a supposed Center; but beginning from the Equator, you shall not need to take that pains; the Equinoctial distances alone from the Substyle, and their natural Tangents (both which are had without trouble of Calculation) being altogether sufficient for this turn, as you may see in the second Table; adjoyn therefore unto each hour and part, the Equinoctial distance thereof from the Substyle (*viz.*) for 6 of the Clock 5 deg. for 5 of the Clock 20 deg. for 7 of the Clock 10 deg. for 8 of the Clock 25 deg. and so of the rest; as you see in the Example: and unto them add the Natural Tangents of each hours distance, so is the Table prepared for Use; by which you may easily frame the Dyal to what greatness you will after this manner.

The Geometrical Projection.

Proportion the Plane B C D E, whereupon you will draw the Dyal, to what Scantling you think fit, as here it is to 4 foot, and 7 foot, allowing for the Scale an inch to a foot; let V R being parallel to B E, be the Horizontal Line drawn where you will, upon any part thereof, as at P; make choice of a fit place for the perpendicular Style (though after you may use another Form) near about the upper part of the Plane, because the great Angle between the two Meridians, maketh the Substyle which must pass through the Point P, to fall so near the 6 of the Clock hour, that you can put but one above it; if you will bring 11 of the Clock more useful than 4, into the Plane, let P be the Center, and with any Chord (the greater the better) make two obscure Arches, one above the horizontal line, the other under the same; from off the same Chord take 51 *d.* 42 *m.* the Angle between the Substyle and Horizon (which is the Complement of the Angle between the Substyle and Meridian) and set it from V, to T, both ways, draw the straight line T P T, which shall be the Substyle of this Dyal: This done, suppose an Equinoctial line in your Imagination (or draw a delible line, if you will) cutting the Substyle at right Angles as near the true place as you can guess; upon which proportion the distance of

either of the extream hours of the Dyal, as great or as little as may juſtly fill the Plane: for example; Let 5 of the Clock be $\frac{75}{100}$ parts of of an Inch from the Subſtyle (which is 9 inches off, accounting an inch to a Foot) and I would find out the length of the Radius agreeable thereto, by which to try if the other extream hour will alſo fall out conveniently upon the Plane; wherefore by the Second Caſe of Right Angled Triangles. I ſay,

	Logar.	
As *r* H, the Tangent of 20 *d.* the Equinoctial diſtance of 5 of the Clock from the Subſtyle ——	+ 956106	Add
Is to the Line *r* H, 075 Parts ——	012494	Add
So is the Radius H G upon the Subſtyle ——	+ 1000000	Subſt.
To the Line H G, or H O, 2061 Parts ——	+ 031400	Rem.

Or by the ſame Caſe,

	Logar.	
As the Sine of *r* G H 20 deg. ——	+ 95340516	Add
Is to the Line *r* H, 75 Parts ——	01249387	Add
So is the Sine of G *r* H 70 deg. ——	+ 99729858	Subſt.
To the Line G H, 2061 Parts ——	+ 03139955	Rem.

Now making the Line G H 206 the Radius, that is 2 inches, and $\frac{6}{100}$ and opening the Sector to the width, try whether 2747, the Natural Tangent of 70 *d.* the Equinoctial diſtance of 11 of the Clock from the Subſtyle ſet off from H, upon the Equinoctial Line, will fall upon the Plane; if not, make this Radius, and conſequently the hours greater or leſſer, till they juſtly fill the Plane, which will follow in due proportion, becauſe the Equinoctial Line K H Y, is a Tangent Line to the Circle drawn upon the Radius or Semi-diameter H G; From this Ground you may alſo find the length of the Radius by the greatneſs of the Plane (as in the 2d. Chapter) add 364 and 2747, the natural Tangent of 5 and 11, the two extream hours together, ſo have you 3111, that is 3 times the Radius, and 1100 Parts for the diſtance of thoſe two hours,

hours, by which divide the Radius (encreaſed for more exactneſs, with as many Cyphers as you will) the Quotient will be 221, or ſeek the Arithmetical Complement of the Logar. of 3111 in the Chiliads (*viz.*) 05071000, and that ſhall give you the length of the Radius 221, as before; then open the Sector to the width of 5 and 11, (which two points you may aſſign where you pleaſe upon the Equator) take thereof 32 parts, which ſhall be the true length of the Radius deſired: When you have fitted the Radius for the two extream hours, all the reſt may be put on by the Tangents proper to them; but it will be firſt neceſſary to find the length of the perpendicular Style, by the help whereof to draw the Equinoctial Line in the true place; therefore in the Triangle H O P, right Angled at P, by the firſt Caſe of right Angled plain Triangles,

	d. *m.*		
As the Sine of H P O	90 00	1000000	} Add.
Is to the Line H O	2061	031400	
So is the Coſine of H O P	3 58	999896	
To the Line O P	2056	1031296	

Now making 2056, (*viz.*) 2 inches, and $\frac{56}{1000}$ parts, the length of the perpendicular Style O P to be the Radius, the Subſtyle T P L ſhall be a Tangent Line thereunto, and P H the diſtance of the Equator from P, is 069 parts, the natural Tangent of 3 *d.* 58 *m.* the height of the Pole above this Plane; by which point H, draw the Line before imagined, which, if you have not erred, will cut the Line at 6 of the Clock, and make an Angle with the Horizon of 38 *d.* 18 *m.* equal to the diſtance of the Subſtyle from the Meridian, upon this Line (making H O, or H G, to be the Radius) you may by the former Rule, with a Scale of Inches, or by the Sector, or by Lines divided equal to H O, by help of the natural Tangents aforeſaid, ſet on all the reſt of the hour-diſtances that you deſire; for example, in 11 of the Clock by the ſecond Caſe of right Angled plain Triangles,

	d. *m.*		
As the Radius H G, or H O,	90 00	1000000	} Add
Is to the Line H O	2061	031400	
So is H 11 the Tangent of H G 11,	70 00	1043893	
To the Line H 11,	5662	1075293	

Which is 5 inches and 66 hundred parts for the diſtance of 11 of the Clock from the Point H; and ſo of the reſt: or for Brevity's ſake, take the

take the Logarithm of HO, 031400, into a peice of Paper, and add it to each Log. Tang. of 5, 10, 25, 40 deg. *&c.* So ſhall you beget new Log. Which being found in the Chiliads, ſhall yield abſolute Numbers; that taken off the Scale of Inches, and ſet from the Subſtyle both ways, will give the true diſtance of each hour, and part upon this Equinoctial Line, agreeable with the Natural Tangents aforeſaid taken off the Sector.

Having done with this Equinoctial, you muſt do the like with another; which may be drawn above or beneath this, without reſpect; to find the place thereof, it will be neceſſary firſt to know the length of the whole Line from H, the Equinoctial to the Center of the Dyal in parts of the perpendicular Style PO, if you will work by the Scale of Inches, or in Natural Tangents, if by the Sector; wherefore by the ſecond Caſe of right Angled plain Triangles.

		d.	*m.*		
As the Radius	PO	90	00	1000000	Add
Is to the Line	PO	206		031407	
So is the Tang. of	POH	3	58	884099	
To the Line	PH	.014		915506	

Again,

		d.	*m.*		
As the Radius	PO	90	00	1000000	Add
Is to the Line	PO	206		031407	
So is the Tangent of	POM	86	02	1175930	
To the Line	P, Center	2,972		2147307	

Add the two Lines of $\frac{014}{}$, and 29 $\frac{72}{}$, together, ſo have you the whole Line 2986, from the Equinoctial to the Center, in parts of the Radius PO (*viz.*) 29 Inches, and $\frac{68}{100}$ parts out of this Line; abate what parts you pleaſe (if you will draw the ſecond Equinoctial above the firſt, or add them, if you will draw it under.) Suppoſe $\frac{343}{}$, that is three inches, and $\frac{43}{100}$ parts, which ſet from H to L, upon the Subſtyle draw another Equinoctial by L, parallel to the former; then will LO be a new Radius for this Equinoctial Line, as HO was for the former; and is thus eaſily found by the 4th. of the 6th. Book of *Euclid.*

As

	Log.	
As the whole Line H, Center		
29 86/100, Complement Arithmetical	852490	Add
Is to the Radius H O in parts 206,	031400	
So is L, Center (343 inches, being abated) 26 43	142210	
To the Radius L O, in parts 1 82/100	1026100	

Having the length of LO, one inch and 82/100 parts, make that the Radius, then ſhall M L 4 be a Tangent-Line thereunto; open the Sector to the width of L O (or by a line of equal Parts) and take off from either of them the ſame hour-Diſtances, which ſet upon this Equinoctial Line, as you did upon the former, you have two pricks for every hour (upon each Equinoctial line one) by which to draw the true hour-lines, without regard to the Center at all. Now may you draw a Line from O to O, at the length of each Radius H O, and L O, which ſhall be the true height of a Triangular Style, repreſenting the Axis to be continued as far as you will; which you may alſo find upon each Equinoctial line; for more certainty-ſake, in this manner, by the firſt Caſe of right Angled plain Triangles.

	d.	m.		
As the Sine of H K O,	86	2	000144	
Is to the Line H O,	206		031400	Add
So is the Radius	90	0	1000000	
To the Line H K	2066		1031544	

Again,

		d.	m.		
As the Sine of	H K O	86	2	Co. Ar. 000144	
Is to the Line	L O	182		026100	Add
So is the Radius	H O K	90	00	1000000	
To the Line	L M	1829		1026244	

Set

Set off 2 $\frac{066}{}$ inches from H, to K, and 1 $\frac{829}{}$ inches from L to M, (by help of a Scale of Inches) ſo have you four Pricks to draw the Axis by.

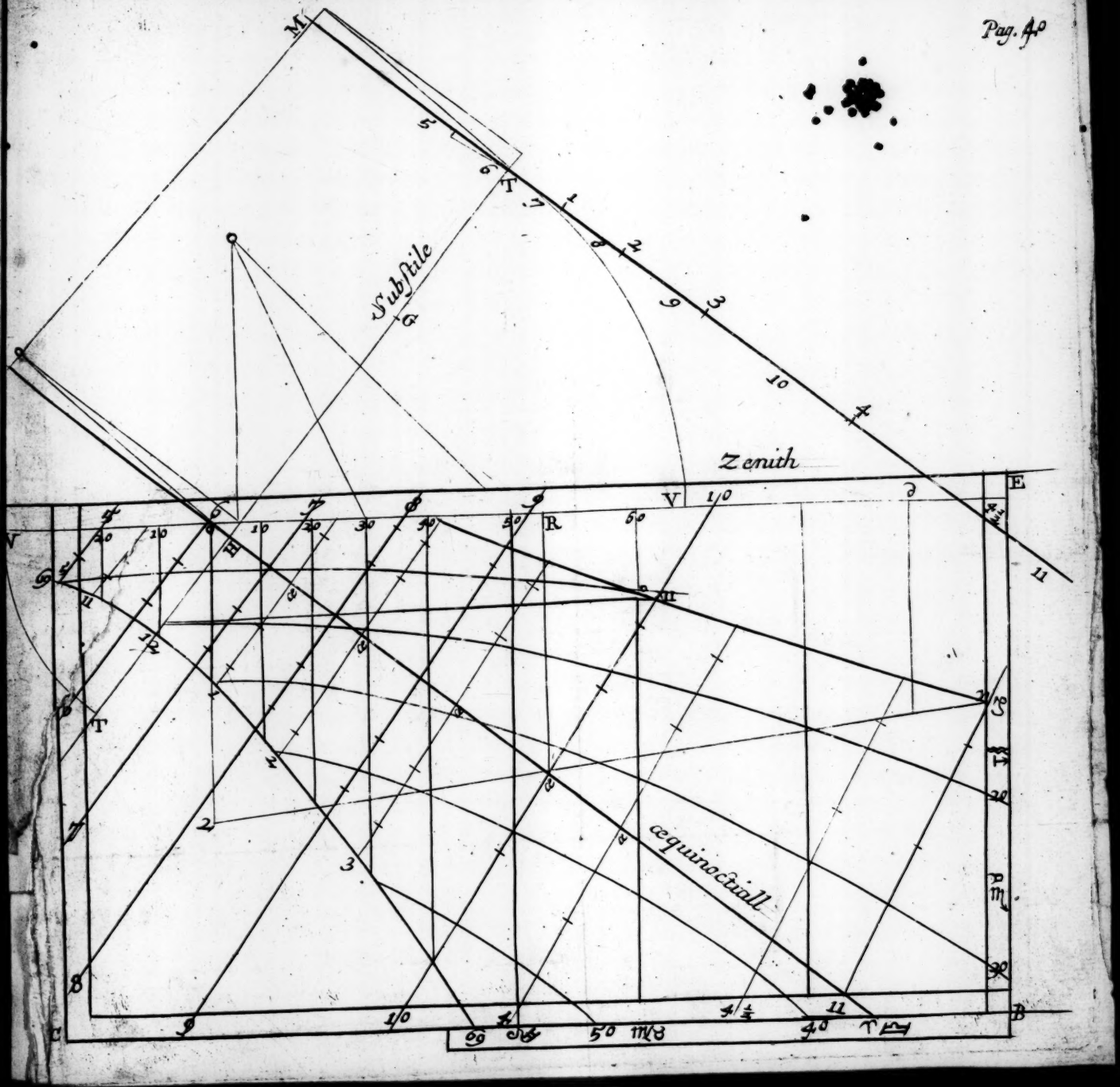
The Operation by Natural Tangents.

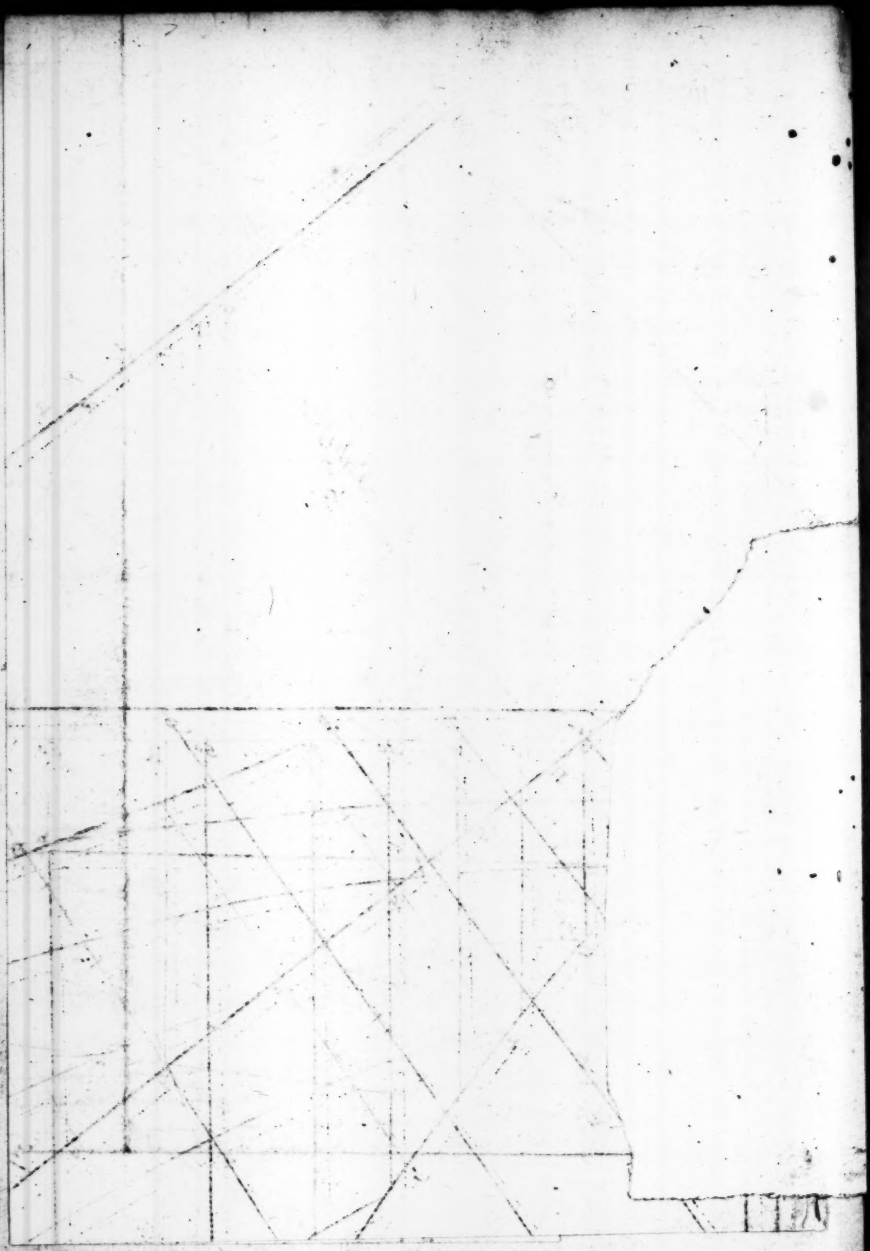
But if you will work by Natural Tangents only, you may with ſome leſs labour attain your Deſire in this manner;

Having drawn the Horizontal line and Subſtyle, as before, proportion the length of P O, the perpendicular Style, to what ſcantling you will; let that be the Radius, which take from off the Sector opened to the width of P O, and ſet it from P, to H: Next, let H O, be the Radius, and ſet off the Natural Tangent of 20 *d.* $\frac{364}{}$ from H, upwards for 5 of the Clock, and the Natural Tangent of 70 deg. $\frac{2747}{}$, from H downward, for 11 of the Clock; if theſe two hour-diſtances fit the plane to your liking, proceed; if not, make P O greater or leſſer as you ſee cauſe, according to which, the diſtance of H from P; by which the Equinoctial line muſt be drawn, and the length of H O, and the width of all the Hour-lines do proportionably vary; or if you like it better, you may at firſt (by the former Rule) find the length of P O, proportionable to the width of the two extream hours 5 and 11; which you may preſcribe at your pleaſure; having fitted the hours upon this Line, draw another: to perform which, let P O, be the Radius again; then is P H, the Natural Tangent of 3 *d.* 58 *m.* 069 parts, and P, Center, the Natural Tangent of 86 *d.* 2 *m.* 14 $\frac{421}{}$; add them together, you have the whole line H, Center 14 $\frac{490}{}$, that is 14 times the Radius, and $\frac{490}{100}$ parts; out of which ſubſtract what Number of parts you will, the reſt is the diſtance from the ſecond Equinoctial to the Center; ſuppoſe $\frac{158}{}$, that is one Radius, and $\frac{58}{100}$ parts; which ſet from H, to L, by the point L, draw the Line M L: 4, parallel to the former Equinoctial, and there will remain from L, to the Center 12 $\frac{91}{}$. Now ſeek the length of L O, which is the Radius for this Line, as H O, was for the former; let H O therefore be given in ſome known parts, 3 $\frac{21}{}$ that is, $\frac{321}{100}$ parts next hand of the width of the two Extream hours 5 and 11, by the former Fourth of the 6th. Book of *Euclid*.

As the whole Line H, Center	14 $\frac{49}{}$	+ 116108	
Is to the Radius H O in parts	321	— 049350	} Add
So is the Line L Center	12 $\frac{91}{}$	+ 111092	
To the Radius L O, in parts	286	— 945634	

Now


M
T
Sub Pile
Zenith
E
V
R
equinoctiall
B



Now making L O the Radius, open the Sector to the width, and ſet on the Natural Tangents of every hours diſtance upon this Equinoctial line, as you did upon the former; ſo you have two Pricks to draw each hour-line by, as you had before; the Axis or Style-line KOMO, is found as in the former Work, which muſt croſs H O and L O at right Angles, and being drawn, you have done.

All this by help of a Line of 12 inches, divided into 10 parts, and $\frac{1}{10}$ part ſubdivided into 100 (as hath been formerly ſhewed) may be eaſily tranſferred from the Paper into the Plane. Thus may you take your choice whether you will give the width of either Extream hour, and from thence argue the length of the Radius, and other things unknown, or elſe give the length of the perpendicular Style, and by that proportion the reſt: or thirdly, give the capacity of the Plane, and thereby collect the length of the Radius, *&c.* for all three ways you may eaſily obtain your Deſire.

And *note*, That if you will content your ſelf with fewer hours, you may put the Subſtyle into the middle of the Plane, and taking in but the Hours of 4 and 9, you may make every hours-diſtance twice as great as it was; but if you be not confined by the Plane, neither are you limited in the width of the hour-lines.

CHAP. XI. *The Ninth Dyal.*

How to draw the Hour-Lines upon any Direct Plane Reclining or Inclining Eaſt or Weſt.

HItherto I have only ſpoken of ſuch Planes as are either parallel, or perpendicular to the Horizon, all which, excepting the Horizontal, lie in the ſame plane of ſome Azimuth or other; the reſt that follow are reclining from the Zenith, or inclining to the Horizon, according to the reſpect of the upper or nether Faces of the Planes. In theſe the Baſe is a Line in the Plane parallel to the Horizon, and always ſituate in ſome Azimuth or other; ſo doth the Baſe of the Eaſt and Weſt reclining Plane, lie in the Meridian, or South and North Azimuth, and the Poles thereof in the prime Vertical; but the Plane it ſelf in ſome Circle of Poſition (as it is Aſtrologically taken) which

is a great Circle of the Sphere, passing by the North and South Intersections of the Meridian and Horizon, and falling East or West from the Zenith, upon the prime Vertical, as much as the Poles of the Plane are elevated and depressed above and under the Horizon, and this kind of Plane rightly conceived and represented in the Scheme by N O S, or N 9 S, is no other but an erect declining Plane in any Country where the Pole is elevated, the Complement of ours: For if you consider the Sphere, it is apparent, that as all the Azimuths representing the Decliners, do cross the prime Vertical in the Zenith, and fall at right Angles upon the Horizon, so do all the Circles of position, representing the reclining and inclining East or West Planes, cross the Horizon in the North and South points of the Meridian, and fall at right Angles upon the prime Vertical; from which Analogy it cometh to pass, that making a Dyal declining 30 deg. from the Meridian, it shall be the same with a reclining 30 deg. from the Zenith, and contrary; only changing the Elevation of the Pole into the Complement thereof, because the prime Vertical in this case is supposed to be the Horizon, above which the Pole is always elevated, the Complement, the height thereof above the Horizon.

Note, All Planes howsoever situated, are horizontal planes in one Latitude or other, and all horizontal Dyals are South Dyals also in that Latitude, that is equal to the Complement of the height of the Style (the height of the Style in all Horizontals being equal to the Latitude of the place wherein they stand) therefore in all inclining declining Planes, or reclining declining Planes, I shall shew you how to find the new Latitude and new Declination of those Planes wherein they may be said to stand as upright Decliners.

Also Note, that all East and West in-reclining Planes are erect declining Planes in that Latitude that is equal to the Complement of the Latitude of the Place, and the Complement of the re-inclination, is the declination of that Plane in that Latitude.

Example.

Let N O S and N 9 S, represent two inclining Planes, (*viz.*) N O S, a West Recliner 35 deg. and N 9 S, an East Incliner 35 deg. the inclination being from 20, and Z 9: then in the Triangle N P R, you have first given N P. the Lat. of the Place, and the Angle N 35, the Planes inclination, to find first the Perpendicular P R, the height of the Pole above the Plane, and the side N R, the distance of the Substyle from the Meridian, and the Angle at P, the Planes difference of Longitude.

For

For the Subſtyles Diſtance from the Meridian.

	d.	m		
As the Radius	90	00	10000000	}
Is to the Cotangent of the new Lat.	38	28	0099913	} Add
So is the Sine of the new Declinat.	55	00	9913364	}
To the Tangent of the Subſtyles diſtance from the Meridian of the Place.	45	52	10013277	

For the Styles Height above the Subſtyle.

	d.	m.		
As the Radius	90	00	10000000	}
Is to the Coſine of the new Declinat.	55	00	9758591	} Add
So is the Coſine of the new Lat.	58	28	9893745	}
To the Sine of the Styles Height above the the Subſtyle (*viz.*) P R	26	41	9652336	

For the Planes Difference of Longitude.

	d.	m		
As the Sine of the new Lat.	38	28	C. A. 0206168	}
Is to the Radius	90	00	10000000	} Add
So is the Tang. of the new Declination	55	00	0154774	}
To the Tang. of the Planes difference of Longitude P.	66	27	10360942	
The Lat. of the Place is N P	51	32		
The Planes Inclination Z O	35	03		
The Planes new Lat. wherein it ſtands an upright Decliner P Z	38	28		

The

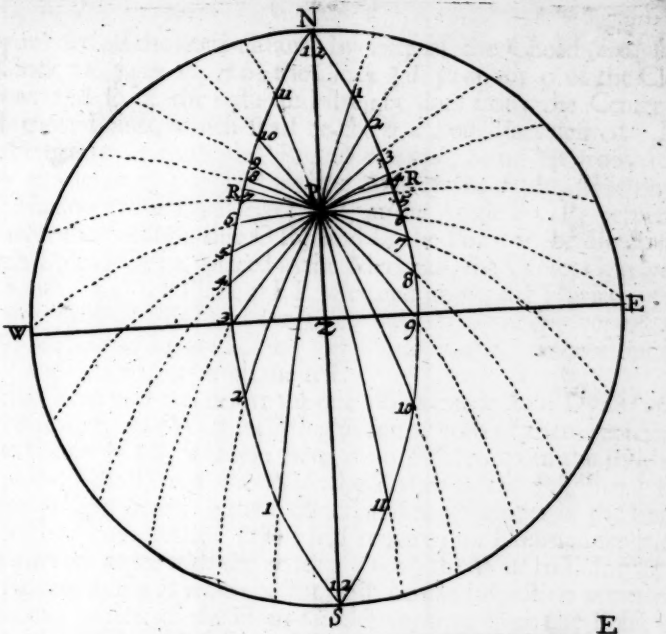
		d.	m.
The Planes new Declination in that Latitude	N W	55	00
The Substyles distance from the Meridian	N R	45	52
The Styles Height above the Substyle	P R	26	41
The Planes Difference of Longitude	R P N	66	27

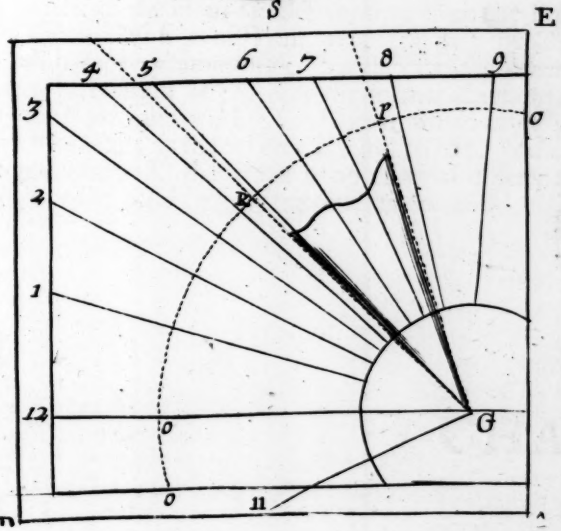
By this Planes Difference of Longitude, make a Table of Hour-Angles, and by them and the height of the ſtyle, find the hours Arches, as you were directed in the making the upright Decliner. The Table follows.

The Geometrical Projection,

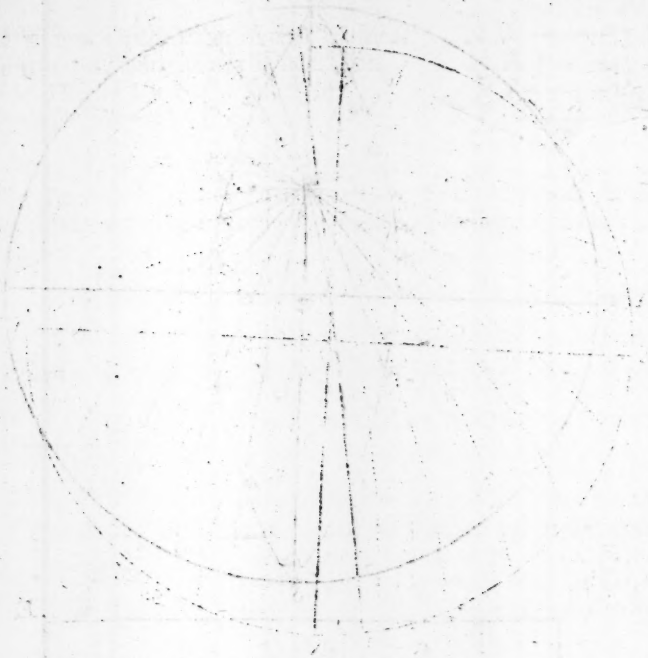
Hours. & Parts from the Subſtyle.		*Hour-Angles.*		*Hour-Arches.*	
H.	*H.*	*d.*	*m.*	*d.*	*m.*
2	10	83	33	75	50
2 ½	9	76	3	61	03
3	9	68	33	48	49
3 ½	8	61	3	39	4
4	8	53	33	31	18
4 ½	7	46	3	24	59
5	7	38	33	19	41
5 ½	6	31	3	15	8
6	6	23	33	11	4
6 ½	5	16	3	7	22
7	5	8	33	3	52
7 ½	4	1	3	00	28
Subſtyle.				*Subſtyle.*	
8	4	6	27	2	54
8 ½	3	13	57	6	22
9	3	21	27	10	00
9 ½	2	28	57	13	57
10	2	36	27	18	21
10 ½	1	43	57	23	25
11	1	51	27	29	24
11 ½	12	58	57	36	43
12	12	66	27	45	51
12 ½	11	73	57	57	21
1	11	81	27	71	29

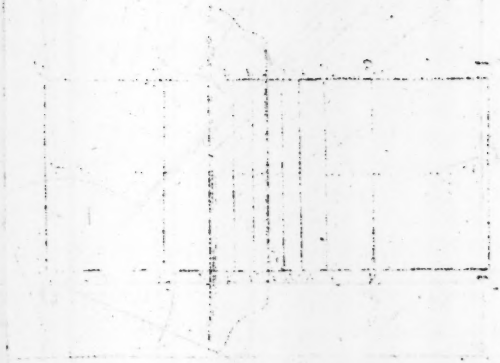
Having Calculated the hour Diſtances, you ſhall thus make the Dyal; Let A D be the Baſe or horozontal Line of the Plane, parallel to N Z S, the Meridian line of the Scheme, and A D E F, the Plane reclining 35 deg. from the Zenith, as doth S ☉ N of the Scheme through any part of the Plane (but moſt convenient for the hours) draw a Line parallel to the Baſe A D, which ſhall be G O 12, the 12 of the Clock hour, repreſenting N Z S of the Scheme, becauſe the Baſe A D, is parallel to the Meridian, take 60 *d.* of the Chord, and making G the Center; draw the Circle P R O, repreſenting the Circle of Poſition N 3 S, of the Scheme, in which this Plane lieth from the Point O, to R, Weſterly, in the Eaſt reclining, and Eaſterly in the Weſt reclining; ſet off the diſtance of the Subſtyle and Meridian, formerly found to be 45 deg. 52 min. and draw the prickt line G R, for the Subſtyle, agreeable to the ſite of P R, in the Scheme G O, of the Dyal, repreſenting the Arch P N, of the Meridian in the Scheme, and O R, the Arch N R, of the Plane from the Point R of the Subſtyle, both ways (as the Table doth direct





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direct you) ſet off the hour-diſtance by help of the Chord (*viz.*) for 8 of the Clock 2 *d.* 54 *m.* for 7 of the Clock 3 *d.* 52 *m.* for 9 of the Clock 10 *d.* 0 *m.* and ſo of the reſt; and ſtraight lines from the Center G, through thoſe Points, which ſhall be the true hour-lines deſired. Laſt of all, the height of the Style P R, 26 *d.* 41 *m.* being ſet from R to P, draw the ſtraight line G P for the Axis of the Style, which muſt give the Shadow to the Dyal erect G P, at the Angle R G P, perpendicularly over the Subſtyle-line G R, and ſet the Point P, be directed to the North-Pole G O, 12, placed in the Meridian, the Center G, reſpecting the South, and the Plane at E F, elevated above the Horizon 55 *d.* ſo have you finiſhed this Dyal for Uſe; only remember, becauſe the Sun riſeth but a little before 4, and ſets a little after 8, to leave out the hour of 3 and 9, and put on all the reſt.

And thus have you (as before) at one Work made four Dyals (*viz.*) the Eaſt reclining, and Weſt inclining as much both of them repreſented by the Circle N 3 S, wherein there is no difference but the ſtyle repreſenting the North, and the Plane the Zenith in the Recliner, but the South-pole and Nadir in the Incliner, and the Number of the hours altered, as the turning of the Dyals will require; in like manner theſe Dyals do directly agree with the other 2 (*viz.*) the Weſt reclining 35 *d.* and the Eaſt inclining as much, as by plain ocular inſpection appeareth in the Scheme, where all the Hour-Circles coming from the Pole, do cut the Planes of the two laſt ſorts of Dyals, repreſented by the Circle of Poſition N 3 S, with the very ſame Angles that they did the other two, repreſent the Circle of Poſition N 3 S, only the former Cautions obſerved of directing the Style, and writing the Hours; which being placed on each ſide the Meridian, as the Scheme it ſelf directeth, you cannot err; theſe things conſidered, that there is no eſſential difference between the Dyals, I make all four to be but one, as aforeſaid.

CHAP.

CHAP. XII. *The Tenth Dyal.*

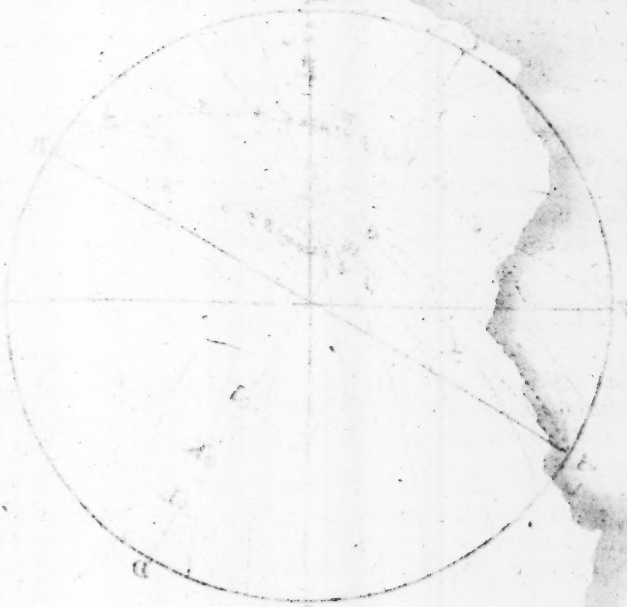
To draw the Hour-Lines upon a Declining reclining, or Declining inclining Plane.

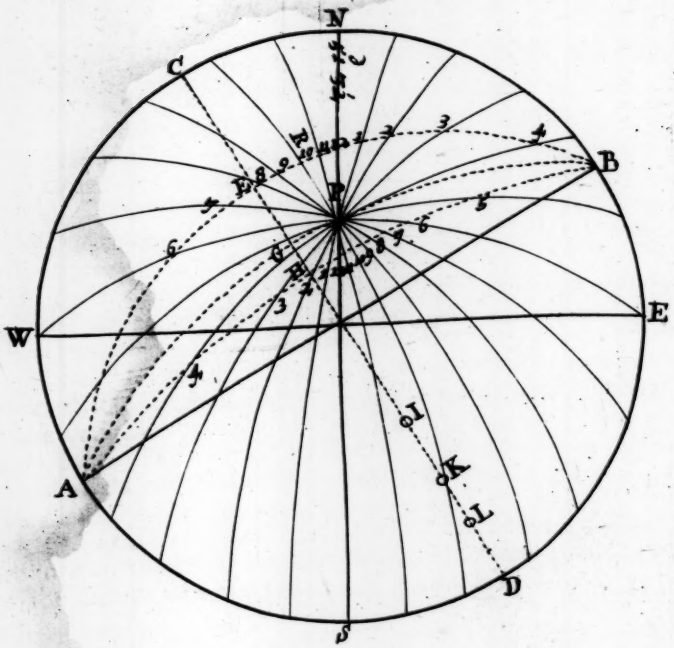
IN Declining reclining Planes, there be the same six Varieties that were in the former, reclining North and South; for either the Decl. may be such, that the reclining Plane will fall just upon the Pole, and then it is called a declining Equinoctial; or it may fall above or under the Pole, and then it is called a South declining East and West Recliner: On the other side, the Declination may be such, that the reclining Plane shall fall just upon the Intersection of the Meridian and Equator, and then it is called a declining Polar: or it may fall above or under the said Intersection, and then it is called a North declining East or West Recliner: Of all which, I will give particular Examples, that by imitation of them nothing may remain doubtful.

And first, For the better understanding of the Work, you may remember that every declining reclining Plane hath both a Base and Flat; the Base perpendicular, but declining; therefore (as before) situate under some Azimuth or other; and the Flat reclining, which to the common mans understanding, is best represented by the Roof of a House, falling back from the Perpendicular of the Wall whereupon it standeth; but upon the Sphere, by the Circle of Position (as afore) supposed to move upon the Horizon with the declining Base, and so fall from the Zenith either ways upon that Azimuth which cutteth the Base at right Angles, by reason whereof the Pole of the reclining Circle is always so much elevated above the Horizon as the Circle it self (representing the Plane) reclining from the Zenith; all which may be plainly seen in the Scheme following.

The First is the Declining Equinoctial represented, whose Base AZB declineth 30 deg. from the East and West Line EZW, equal to the Declination of the South Pole thereof, 30 deg. from the South part of the Meridian S. Easterly unto D, the reclining Plane is AGB, reclining from the Zenith Z, upon the Azimuth CZD, the quantity of ZG, 34 *d.* 32 *m.* and passeth through the Pole P; set off from D to Q, the Reclination ZG and Q, shall represent the Pole of the reclining Plane so much elevatrd above the Horizon at D; as the Circle AGB, representing the Plane, declineth from the Zenith Z, from the

Pole





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Pole of the World P, to the Pole of the Plane Q; draw an Arch of a great Circle P Q, whose Center will fall upon the Periphery of the reclining Plane, seeing it cuts the same at right Angles in P; and because some may be desirous to any declination given, to fit a Plane reclining just to the Pole, or any reclination being given to find the declination proper to the same, this Diagram will satisfie them therein, in the Triangle Z G P; let D S, or C N the Declination, be given, and P N the Elevation of the Pole, to find the Arch G Z, by the first Case of right angled Spherical Triangles. Thus;

	d.	m.		
As the Co-tangent of P Z, the Complement of the Lat. of the Place,	38	28	C. A. 9900087	
Is to the Radius	90	00	10000000	
So is the Cosine of the Angle G Z P, the Declination given,	30	00	9937531	Add
To the Tangent of Z G the Reclination required	34	32	9837618	

Or having the Reclination given, you may find the Declination answerable thereto, by the 10th. Case of right angled Spherical Triangles. Thus;

	d.	m.		
As the Radius	90	00	10000000	
Is to the Co-tangent of Z P, the Compl. of the Latitude	38	28	10099913	Add
So is the Tang. of Z G, the Reclination given	34	32	9837675	
To the Cosine of the Angle G Z P, the Declination required,	30	00	9937588	

The Arithmetical Calculation.

In this first Example you are to find two things: First, The Arch of the Plane, or Distance of the Meridian and Substyle from the horizontal

zontal Line, which in this Scheme is P B, the Intersection of the reclining Plane with the Horizon, being at B: And secondly, The Distance of the Meridian of the Place S Z P N, from the Meridian of the Plane P Q, which being had, the Dyal is easily made; wherefore in the Triangle Z G P, right angled at G, you have the Side G Z, given, 34 *d.* 32 *m.* the Reclination, and you have Z P given 38 *d.* 28 *m.* the Complement of the Elevation, and the Angle at Z, 30 *d.* whose measure is N C, the Declination, to find G P, whose Complement is P B, either by the small Triangle Z G P, or by the Triangle P N B, you may without the Complement find P B, your Desire, by the Second Case of right angled Spherical Triangles. Thus;

	d.	*m.*		
As the Radius	90	00		
Is to the Sine of P Z, the Compl. of the Lat. of the Place	38	28	10000000 / 9793832	Add
So is the Sine of the Declination G Z P	30	00	9698970	
To the Sine of G P, the Compl. of the Dist. of the Meridian and Horizon	18	7	9492802	

The second thing to be found, is the distance of the Meridian of the Place, which is the hour of 12 from the Substyle or Meridian of the Plane, which is the Angle it self of the two Meridians, represented by Z P Q.

Now to find this Angle Z P Q, you must first find the Angle Z P G, which taken out of G P Q, 90 deg. leaveth the Angle Z P Q; by the 12th. Case of right angled Spherical Triangles. Thus;

	d.	*m.*		
As the Sine of the Complement of the Lat. of the Place P B,	38	28	C. A. 0206168	
Is to the Radius	90	00	10000000	Add
So is the Sine of the Planes Reclinat. Z G	34	32	9753495	
To the Sine of the Angle Z P G	65	45	9959663	

The Complement of which to 90 deg. is the distance of the Substyle from the Meridian, and is likewise the Planes difference of Longitude;

This

This may be found by the third Case of right angled Spherical Triangles. Thus;

	d.	m.		
As the Cotangent of the planes Declination (*viz.*) the Angle G Z P	30	00	C. A. 9761439	
Is to the Radius (*viz.*) the Angle P G Z	90	00	10000000	Add
So is the Cosine of Z P, the Complement of the Latitude of the Place	38	28	9893745	Add
To the Cotangent of the Angle Z P G,	65	41	9655184	

Which 65 deg. 41 min. being substracted from 90 deg. leaves the Planes difference of Longitude and distance of the Substyle from the Meridian, as before.

Now because 24 *d.* 19 *m.* is more then 15 *d.* one hours distance from the Meridian, and less than 30 *d.* 2 hours distance, I conclude that the Substyle shall fall between 10 and 11 of the Clock on the West side of the Meridian, because the Plane declineth East, and as the very Scheme it self directeth, being inverted or drawn to the South-pole, as indeed it ought to be.

Given.

The elevation of the Pole above the Horizon P N——51 *d.* 32 *m.*
The Planes declination from the South towards the East S D or C N,——30 00
The reclination of the Plane from the Zenith Z G,——34 32

Required.

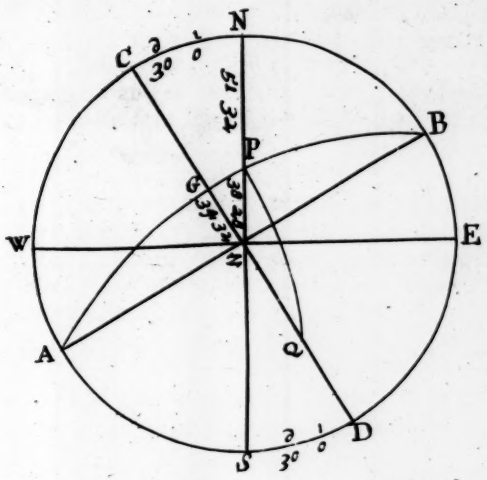
1. The Height or Length of the Style above the Substyle E F--02957
2. The Distance of the Horizon and Meridian P B,——71 *d.* 53 *m.*
3. The Angle between the Meridians Z P Q,——24 *d.* 19 *m.*

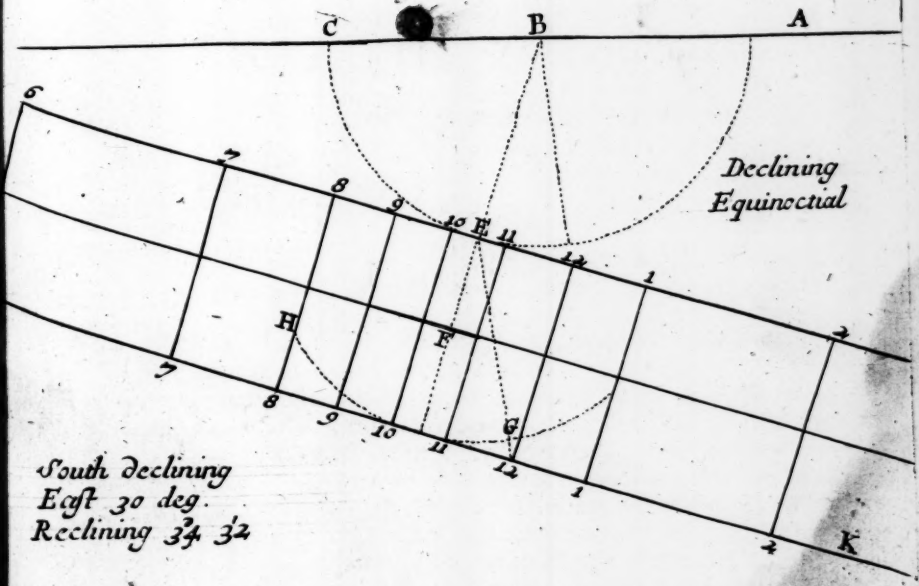
Having these things found, you may frame a Table of Hour-Angles, as you were formerly directed in other declining Dyals, and thereunto annex the Natural Tangent of each Arch, as in the Table following.

Hours from the Substyle.		Hour-Angles. d. m.	Natural Tang.
5	7	80—41	6 039
6	6	65—41	2 213
7	5	50—41	1 221
8	4	35—41	0 718
9	3	20—41	0 377
10	2	5—41	0 009
Substyle.			Substyle.
11	1	9—19	0 164
12	12	24—19	0 452
1	11	39—19	0 819
2	10	54—19	1 392
3	9	69—19	2 648
4	8	84—19	10 048

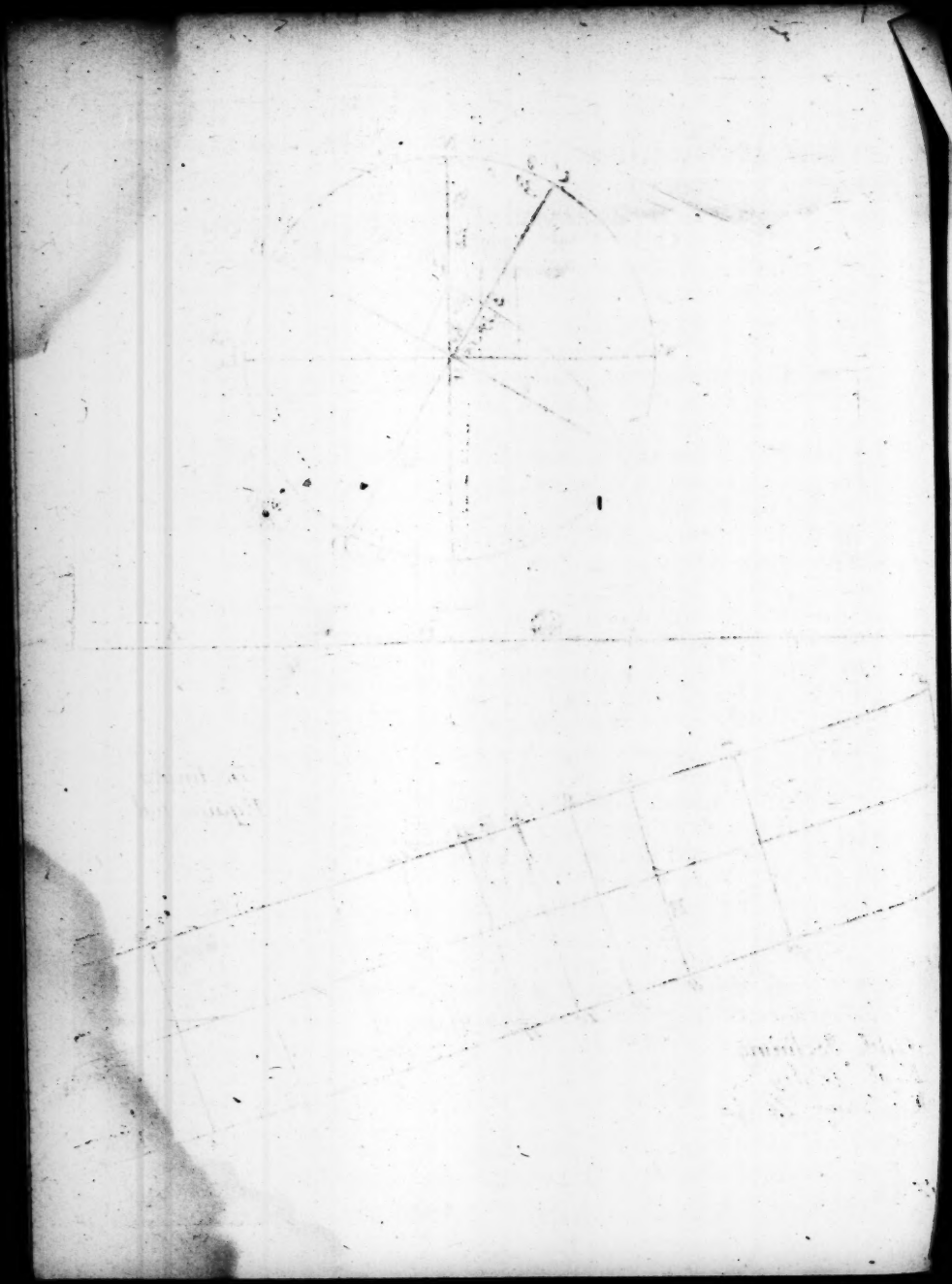
The Geometrical Projection.

To draw this Dyal true, conſider the Scheme; let A B C D be the Horizontal Line, drawn upon the reclining Flat, moſt convenient for the Hour-Lines, which will be always parallel to the Baſe thereof, repreſenting A Z B, of the Scheme, upon any part of this Line, as at B: make an Arch of a Circle C E O, (equal to 60 deg. of the Chord) repreſenting A G B, the reclining Plane in the Scheme from C, unto E, reckon the diſtance of B P in the Scheme between the Horizon and Meridian, which giveth the place of the Subſtyle on the Weſt ſide of the Center B, when the declination is Eaſterly, on the Eaſt ſide; when Weſterly, agreeable to the Scheme inverted; through the Point E, draw the Line B E F for the Subſtyle-Line upon E, or any other part of the Subſtyle, where you will make another Arch of a Circle (with the ſame Chord) F O H; for the Equinoctial, croſs the Subſtyle at right Angles, both in E and F; 6 E 3, and L F K, ſhall be two Tangent-Lines to the Arches C E O and F G H, drawn with the Semi-diameters B E, and E F, upon the Arch G F H, from F to G, reckon the Angle between the Meridians 24 *d.* 19 *m.* or take the Natural Tangent thereof 0452, (opening the Sector to the Radius E F, and ſet it upon the ſtraight Line F K, from F to N: Do the like upon the other Arch and Tangent-line E 3, and draw the Lines E G N, and B O 12. whoſe interſections upon the Tangent Lines ſhall be in the Meridian of the Place, and that Eaſterly from the Subſtyle, when the declination is Eaſt (as in this Example) but Weſterly, when the Plane declineth Weſt (becauſe in this Dyal the Subſtyle is firſt given, and the Meridian found from that) ſet off the reſt of the Tang. from F and E, both ways, by help of the Sector or a Line divided





South declining
East 30 deg.
Declining 34 32



vided into 100 parts, as you find them in the Table (*viz.*) for 11 H, 0164. for 1 H, 0819. for 2 H, 1302. and ſo of the reſt; unto every one of theſe Points draw parallels to the Subſtyle, which will croſs the Tangent-Lines at right Angles, and ſo be all the hour-lines truly drawn; the Style muſt either be a ſtraight Pin of the length of E F, the Radius erected perpendicularly upon the Plane in the Point F; or elſe a long Square at the ſame height erected over the Subſtyle, and ſo is the Dyal finiſhed for Uſe: And further you may note, That by the Rules before-going, you may proportion both the length of the Style, and width of the hour-lines to the capacity of the plane, ſeeing that L F K is a Tangent-line to the Rad. E F, as you ſee done by the Tangents of F L, and F K, the two extream hours of the Dyal; the Dyal being drawn, and placed according to the declination 30 *d.* Eaſterly, and the whole Plane at E, raiſed to an Angle of 55 *d.* 28 *m.* the Complement of the Reclination, the Shadow of the Style ſhall give the hours of the Day deſired.

CHAP. XIII. *The* 11*th. Dyal.*

To draw the Hour-Lines upon a South reclining Plane, declining Eaſt or Weſt, which paſſeth between the Zenith and the Pole.

Example 2.

IN theſe kind of declining reclining Planes, the South-Pole is elevated, as may appear in the Diagram, *Fig.* 5.

Wherein the Circle A H B, repreſenteth the Plane, falling between the Zenith Z, and the North-pole P, and therefore hideth that Pole from the Eye, and forceth you to ſeek the elevation of the contrary Pole above the Plane, which notwithſtanding maketh the like equal Angle upon the South-ſide objected to it, as the North-pole doth upon the North-ſide; ſo that either you may imagine the Scheme to be turned upſide down, and the North and South points changed, and then it will repreſent the South part of Heaven; or you may calculate the Hours as it ſtandeth, remembring to turn the Style upwards or downwards

wards, and change the Numbers of the hours, as the Nature of the Dyal will direct you.

Example.

Let the Lat. of the Place, or the Elevation of the Pole P S, 51 *d.* 32 *m.* the reclination of the Plane Z H, be 20 *d.*

And let the Plane decline from the South towards the East, which in *Fig.* 5. will be S C, 30 *d.* These Planes may be referred to a new Latitude, in which they shall stand as upright Planes.

Note, The Meridian-line is not here to be taken for the line of 12 at Mid-Day; for it often represents the Midnight, but for that part which helps to describe the Dyal.

Now for finding the new Lat. wherein this Plane stands as an upright Decliner, you have in the Triangle Z H O, right angled at H, the side Z H, given, it being the reclination of the Plane with the Angle H Z O, the old declination, and the right Angle H, to find first Z O (the difference between which and the side Z P, is the complement of the new Latitude.) Secondly, the Angle H O Z, the complement of which to 90 deg. is the new declination. First, for the new declination by the sixth Case of right angled Spherical Triangles; Thus;

	d.	*m.*		
As the Radius———————————	90	00	10000000	} Add
Is to the Cosine of the Planes reclinat. Z H—	20	00	9972986	
So is the Sine of the old Planes decl. H Z O—	30	00	9698970	
To the Cosine of the Angle ——— H O Z—	61	59	9671956	

Which being substracted from 90 deg. gives the new declination, Then for the new Latitude, by the Fourth Case of right angled Spherical Triangles: Thus;

	d.	*m.*		
As the Tangent of the Planes reclinat. Z H	20	00	*C. A.* 0438934	} Add
Is to the Radius———————————	90	00	10000000	
So is the Cosine of the Planes declinat. H Z O	30	00	9937531	
To the Cotangent of the Arch O Z———	22	48	10376465	

This

This Arch ZO, 22 *d.* 48 *m.* being ſubſtracted from ZP, the compl. of the Lat. of the place, leaves the compl. of the new Lat. Having found the new Lat. and Declinat. you may find the Diſtance of the Subſtyle from the Meridian, the height of the Style above the Subſtyle, and the Planes difference of Longitude, as you were directed in the Eleventh Chapter, in erect declining Planes, and they will be found to be as here you ſee.

	d.	*m*
The Latitude of the Place, or height of the Pole above the Horizon PS	51	32
The declination of the Plane SC, or the Angle HZO	30	00
The Planes reclination from the Zenith ZH	20	00
The Planes new Latitude wherein it ſtands as an upright Decliner	74	14
The Planes new Declination in that Latitude,	28	01
The Subſtyles Diſtance from the Meridian RO,	07	33
The Styles Height above the Subſtyle RP.	13	53
The Planes Difference of Longitude, the Angle OPR	28	56

Having thus found the Longitude, and the reſt of the things neceſſary, you may frame a Table of Angles at the Pole, as was directed in the 9th. Chapter, in upright Decliners; and from thence you may find alſo the Hour-Arches, and ſet them down in a Table, as you ſee here followeth.

Hours from the Subſtyle.	*Angles at the Pole.*		*Hour-Arches.*		*Hours from the Subſtyle.*
H.	*d.*	*m.*	*d.*	*m*	H.
4	88	56	85	16	8
3	73	56	39	32	9
2	58	56	21	34	10
1	43	56	12	55	11
12	28	56	7	30	12
11	13	56	3	22	1
Subſtyle.					*Subſtyle.*
10	1	4	0	16	2
9	16	4	3	57	3
8	31	4	8	12	4
7	46	4	13	57	5
6	61	4	23	25	6
5	76	4	44	3	7

There is one thing more that is very neceſſary to be found in theſe kind of Dyals, which is the Diſtance of the Meridian from the Horizon OB; to find which, you have ZH, the Planes reclination, and the Angle HZO, the planes old declination, to find the ſide HO (the Angle being right angled at H) the Complement whereof to 90 *d.* is OB, the diſtance of the Meridian and Horizon, by the 5th. Caſe of right angled Spherical Triangles:

Thus

Thus;

	d.	m.	
As the Cotangent of HZO,	30	00	C. A. 9761439
Is to the Radius OHZ,	90	00	Add
So is the Sine of HZ,	58	40	9534052
To the Tangent of HO,	11	10	9295491

This HO, 11 *d.* 10 *m.* being subtracted from HB, 90 *d.* there will remain OB, the distance of the Meridian and Horizon.

The Geometrical Projection.

First draw the horizontal line A C B, in the upper part of the plane, because the Style of this Dyal must look downwards to the South-pole, and this line in all Recliners will be parallel to the Base, representing A C B, of the Scheme; upon any part of this line, as at C, make the Circle A D B (with 60 deg. of Chord) representing the reclining Circle of the Scheme A H B; and because this plane declineth East, the Substyle and all the Morning-hours must stand on the West side of the Meridian, as the great Scheme, *C.* 12. doth demonstrate: If you suppose P, to be the South-pole, and the next side of the reclining Flat A H B, to the pole, to be the South side thereof; but the particular Scheme will better direct you to reckon the distance of the Meridian and Horizon in the Dyal from A, the West part of the horizontal line as B, standeth from S in the Scheme, that so the Substyle may stand to the Westward of the Meridian, or the complement of that distance to 180 deg. from B, the East part of the Dyal, both which will bring the 12 of the Clock hour into the due place, agreeable with the Scheme (*viz.*) A E, to B O, and E D, to R O. Therefore by help of the Chord, set off the distance of the Meridian and Horizon 78 *d.* 50 *m.* from A to E, and draw the Line C E 12; for 12 of the Clock hour from E, reckon 7 deg. 30 min. the distance of the Substyle and Meridian Westwards, as R standeth from O, in the Scheme, and draw the prickt Line C D, for the Substyle from the point D, of the Substyle set off either way by help of the Chord, the true hour-distances of 3 *d.* 22 *m.* for 11 of the Clock, and 7 *d.* 30 *m.* for 12 of the Clock; and so of the rest, as they stand in the Table, unto every Prick draw a straight Line from the Center C, so have you all the hours truly drawn.

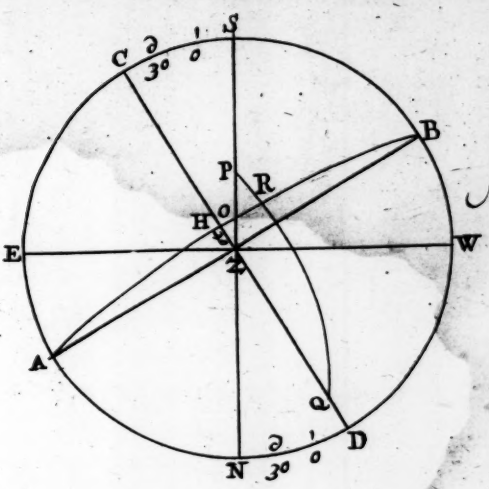
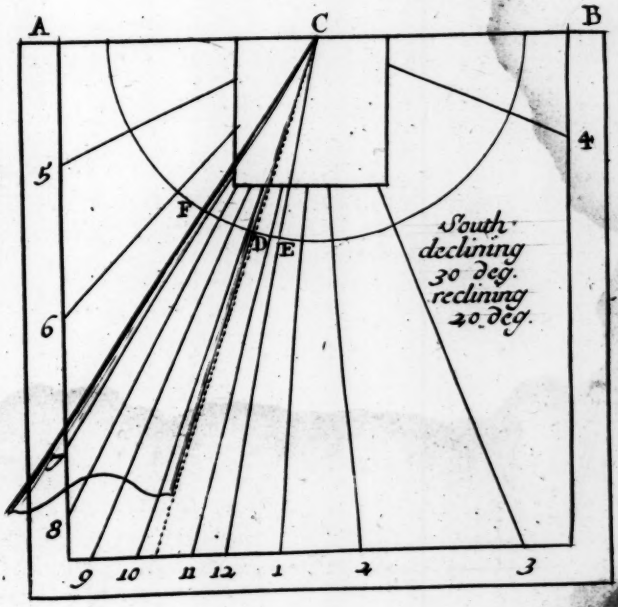

C
S
B
P
R
H
E
W
A
Q
D
N

fig. 5


A
C
B
5
4
F
D
E
South
declining
30 deg.
reclining
20 deg.
6
8
9
10
11
12
1
2
3

drawn. Last of all, Set off from D, the height of the Style D P, 13 d. 49 m. and draw the Line C F, for the Axis, which Erected directly over the Substyle C D, the Dyal is perfected for use; but must be placed in its due position by the declination and reclination thereof.

Now in this one kind of Dyal you have made four (as aforesaid) only turning the Style, and placing the numbers of the hours as the Plane requireth (*viz.*) a South-declining East, or West reclining 20 deg. or a North-declining East, or West inclining as much, as you may easily collect out of the Analogy of the four Dyals.

CHAP. XIV. *The 12th Dyal.*

To draw the Hour-Lines upon a South reclining Plane declining East or West, which passeth between the Pole and Horizon.

Example 3. *Fig.* 6.

THE Third Variety in South-declining reclining Planes, is of those that pass between the Pole of the World and Horizon, as is represented by the Circle of Reclination A F B, in the 6th. Fig. in this Example, because the Plane falleth under the North-pole, therefore that Pole is elevated above it; from whence you conclude the Center of the Dyal must stand downwards upon the Plane contrary to the former, the Style must also point to the North-pole, and the hour-line must look the same way likewise.

Example.

	d.	m.
Let the Lat. of the Place, or Elevation of the Pole P N, be	51.	32
The Reclination of the Plane be Z F,	55.	00
And let the Plane decline from the South towards the East S D, equal to C N, or the Angle F Z O, be	30.	00

Now

Now for the finding of the Lat. of the Place wherein this Plane ſtands as an upright Decliner, you have in the Triangle F Z O, right angled at F, firſt Z F, the Planes reclination 55 deg. and the Angle F Z O, the Planes declination 30 deg. to find Z O, the complement of the new Lat. by the firſt Caſe of right angled Spherical Triangles. Thus;

	d.	m.		
As the Tangent of the Planes reclination Z F,	55	00	C. A.	9845226
Is to the Radius——— O F Z	90	00		10000000 } Add
So is the Coſine of the Planes dec. F Z O	30	00		9937531 }
To the Co-tangent of——— O Z	58	46		9782757
The Complement of the Latitude of the Place Subſtract.	38	28		
And there remains the Complement of the new Latitude	20	18		

The referring of this Plane to a new Latitude, doth alter the Declination alſo; therefore the new Declination being the Complement of the Angle F O Z, to 90 *d.* and may be found by the Second Caſe of right angled Spherical Triangles: Thus;

	d.	m		
As the Radius O F Z	90	00		10000000 }
Is to the Coſine of the Planes reclination Z F	55	00		9758591 } Add
So is the Sine of the Planes declination, F Z O	30	00		9698970 }
To the Coſine of the Angle F O Z	73	20		9457561

Which being Subſtracted from 90 *d.* gives the Planes declination in that Latitude wherein it ſtands as an upright Decliner.

Having thus found the new Latitude, and new Declination, you may find the Subſtyles diſtance from the Meridian, and the Styles height above the Subſtyle, the Planes difference of Longitude, as you were directed in Chapter 9. Only *Note*, Where you uſed the Latitude of the

the place, you must use the new Latitude, and instead of using the declination of the place, you must use the new declination. The distance of the Meridian from the Horizon, may be found, as was directed in the last Chapter; and then it would be convenient you should stand thus:

	d.	m.
The Latitude of the place, or height of the Pole,	51	32
The declinat. of the plane from the South toward the East S D	30	0
The reclinat. of the plane from the Zenith Z P	55	0
The new Lat. of the place wherein the Plane standeth upright	69	42
The planes new declination in that Latitude,	16	40
The Substyles distance from the Meridian R O	6	3
The height of the Style above the Substyle, R P,	19	25
The Planes difference of Longitude R P O	17	42
The distance of the Meridian and Horizon, B O	64	41

Note, The distance of the Meridian and Horizon may be found in the Triangle O N B, right angled at N, and it will be found at once (by the first Case of right angled Spherical Triangles) for you have the Base B N, the complement of the planes declination, and the Angle O B N, the complement of the Planes reclination with the right Angle B N O, given to find the side B O: Thus;

	d.	m.		
As the Tangent B N, the Complement of the Planes declination,	60	0	C.A. 9761439	}
Is to the Radius	90	0	10000000	}
So is the Cosine of the Angle O B N, the Comp. of the Planes reclination,	35	0	9913364	} Add
To the Co-tangent of the dist. of the Meridian and Horizon, B O,	64	41	9674803	

Having found the Requisites, you may frame a Table of Angles at the Pole, according to the direction of the 9th. Chapter. From thence you may find the hour-Arches, and set them down as you see in the Table following.

The Geometrical Projection,

Hours from the Subſtyle.	*Hour-Angles*		*Hour-Arches.*		*Hours from the Subſtyle.*
H.	*d.*	*m.*	*d.*	*m*	H.
5	87	22	82	7	7
6	72	22	46	17	6
7	57	22	27	26	5
8	42	22	16	52	4
9	27	22	9	46	3
10	12	22	4	10	2
Subſtyle.					*Subſtyle.*
11	2	38	0	53	1
12	17	38	6	2	12
1	32	38	12	1	11
2	47	38	20	1	10
3	62	38	32	42	9
4	77	38	56	35	8

The Table being prepared, and the hours-diſtances calculated, draw the horizontal Line A C B, parallel to the Baſe, repreſenting A Z B, of the Scheme, towards the lower part of the Plane, becauſe the Center muſt ſtand downwards, and the Style and hours point upwards to thee Pole, as appears by the very inſpection of the Scheme in any part of the horizontal Line, as at C, place the Center, and with the length of 60 *d.* of the Chord, draw the Arch A D E B, repreſenting the reclining Circle A F O B, of the Scheme; in this Arch place the Meridian Subſtyle, and Hours as they lie in the Scheme, and you cannot do amiſs; (*viz.*) from B, the Eaſtern part of the Horizontal line of the Dyal ſet off by help of the Chord unto 1; B O of the Scheme 64 *d.* 41 *m.* the diſtance of the Meridian from the Horizon, and draw C M 12 for 12 of the Clock hour, from the line of 12, unto E, reckon O R, of the Scheme, 6 *d.* 2 *m.* the diſtance of the Subſtyle from the Meridian; which ſet off Weſtwards agreeable to the Sheme, becauſe the declination is Eaſtward; and draw the prickt line C E, for the Subſtyle, from the Point E, both ways; ſet off by the help of the Chord, the hour-diſtances of 10, 9, 8, 7, 6, 5, to the Weſtward thereof; and 11, 12, 1, 2, 3, 4, to the Eaſtward, for the reſt of the hours, and to each Prick draw ſtraight Lines from the Center; ſo is the Dyal finiſhed for Uſe. Laſt of all, ſet off the height of the Style P R, 19 *d.* 25 *m.* from E, to D, and draw the Line C D, repreſenting the Axis, which being erected perpendicularly over the Subſtyle-line C E, the Baſe A C B, declining 30 *d.* Eaſtwards, and the whole Plane at 6, 12, raiſed to an Angle of 35 deg. above the Horizon, will ſhadow the true hour-lines upon the Plane, and ſo you have done with the three Varieties of South

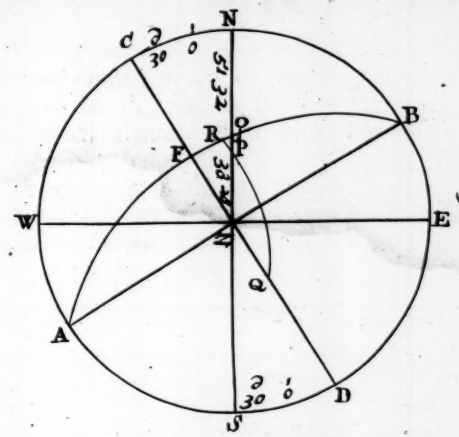
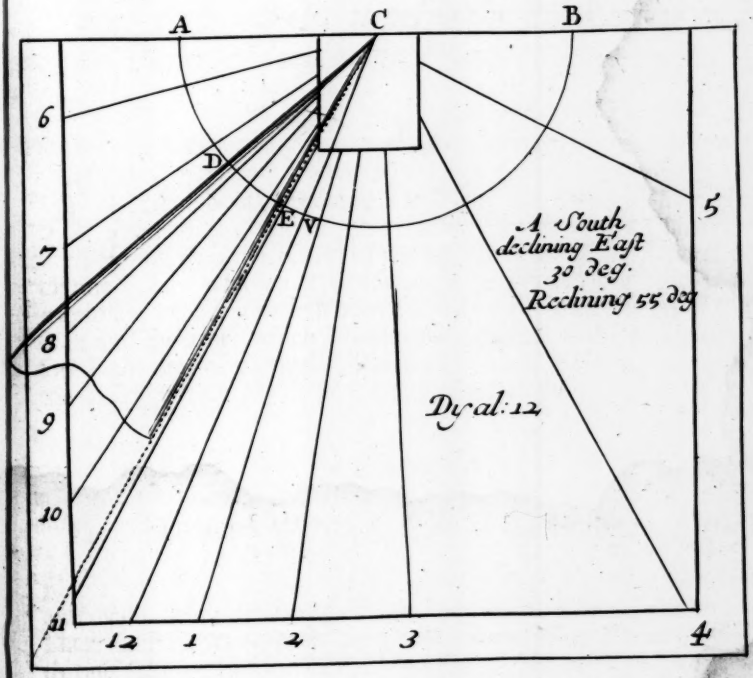
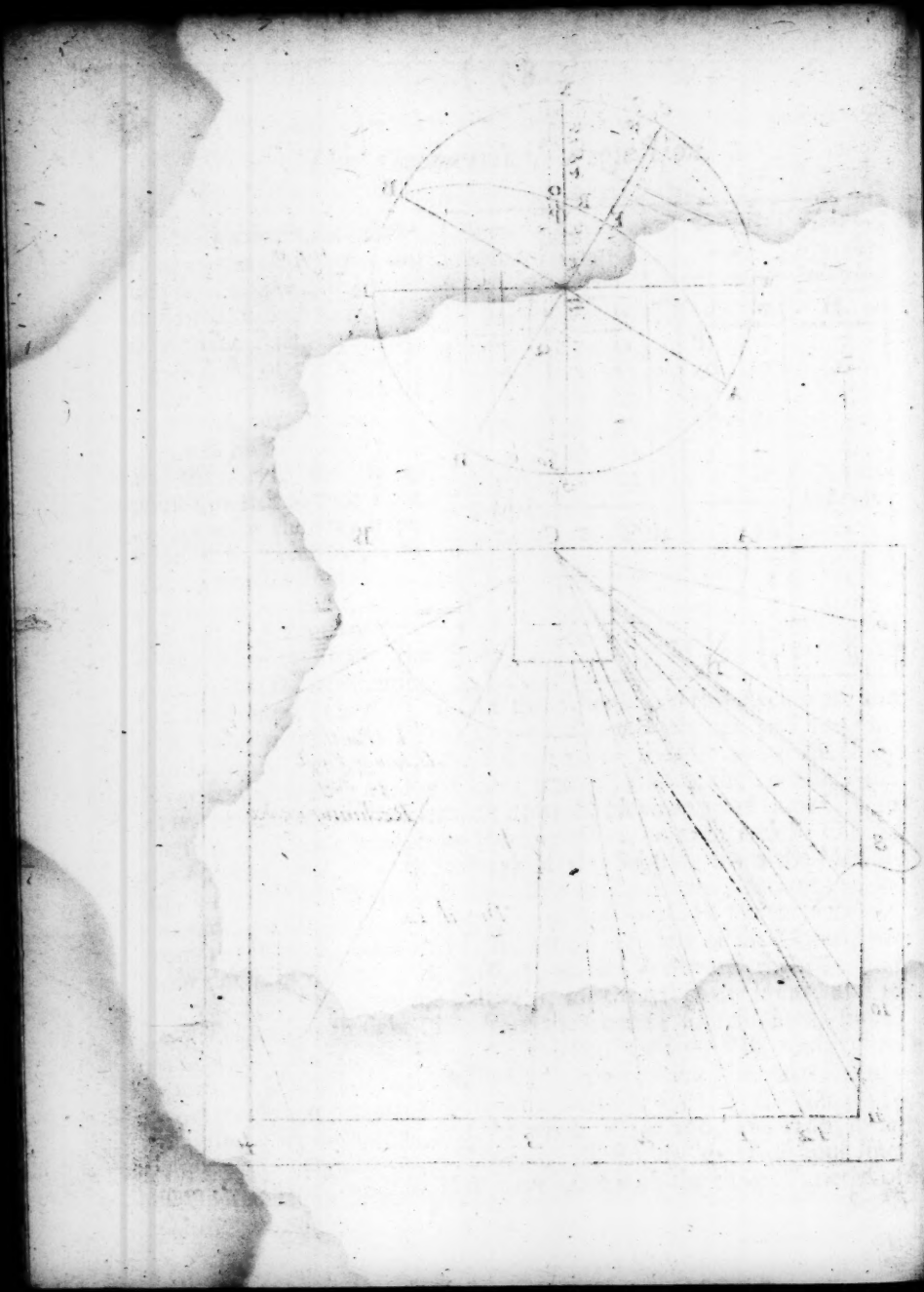

N
C
30
0
51 32
R
O
B
F
33 28
W
E
Q
A
30
0
D
S

fig. 6


A
C
B
6
D
5
7
E
V
A South
declining East
30 deg.
Reclining 55 deg
8
9
Dyal: 12
10
11
12
1
2
3
4



South-declining reclining Dyals: Wherein alſo note, That having made this one Dyal (or any of the like) you have at once made four; changing but the Poſition of the Dyals, and altering the number of the Hours, as the Plane doth require: For firſt, this anſwereth to the oppoſite, the North declining 30 *d.* Weſt, and inclining to the Horizon, the complement of the reclination 35 *d.* alſo the South declining 30 *d.* Weſt, reclining 50 *d.* or to his oppoſite North, declining Eaſt 30 *d.* and inclining to the Horizon 35 *d.*

CHAP. XV. *The 13th. Dyal.*

To draw the Hour-Lines upon the Polar Plane Declining Eaſt or Weſt, it being the firſt Variety of North declining and reclining Planes.

Fig. 1.

AS in the South reclining Decliners, there were Three Varieties, ſo are there in the North as many; for either the Planes reclining doth paſs by the interſection of the Meridian and then it is called a declining Polar, which hath the Subſtyle always at right Angles with the meridian, or elſe it paſſeth above or under the interſection of the Meridian and Equator, which is ſomewhat different from the former; therefore I will draw a particular Diagram to each Variety, and proceed to the making of the Dyals proper to each of them.

Example 1.

Let the Diagram W N E S, repreſent the Horizontal Circle in *Fig.* 7. and let Z be the Zenith; Let A Z B, be a declining Plane, declining from the North part of the Horizon at N, towards the Weſt 60 *d.* and recline from the Zenith Z, 32 *d.* 11 *m.* and let the Latitude of the Place be P Z, 51 *d.* 32 *m.* then will the reclining Plane A G B, paſs through the interſection of the Meridian and Equator Æ; then will the Plane be an upright Decliner in thoſe places where the Pole lies in the

Horizon, and by consequence have no new Latitude; the new Declination is the Angle G Æ Z, and P R, is the height of the Style above the Substyle, the Substyle being always distant from the Meridian 90 d. the Meridian from the Horizon being A Æ. Now if you have a Declination given, and you would find what Reclination that Plane must have, so that it might become a declining Polar in the Triangle Z G Æ, right angled at G, you have the Angle G Z Æ, and the Side Z Æ, the distance of the Equator from the Zenith, to find the Perpendicular Z G, the Planes Reclination sought; which you may find, Thus;

	d.	m.		
As the Co-tangent of the Latitude of the Place Z Æ,	51	32	C. 10099913	
Is to the Radius (*viz.*) the Angle Z G Æ	90	0	10000000	Add
So is the Cosine of Declination of the Plane, G Z Æ,	60	0	9698970	
To the Tang. of the Reclination Z G,	32	11	9798883	

Or if you have the Reclination given, and would find a Declination answerable thereto, you may do it by the same Triangle, Thus;

	d.	m.		
As the Radius	90	0	10000000	A
Is to the Tangent of Z G, the reclination,	32	11	9798877	Add
So is the Cotangent of Z Æ, the Lat.	51	32	9900086	
To the Cosine of the Angle Æ Z G, the declination required,	60	0	9698963	

In these sorts of Planes, you have only the height of the Style above the Substyle (*viz.*) P R, and the distance of the Meridian and Horizon, to find (*viz*) A Æ; now forasmuch as the distance of the Substyle from the Meridian is 90 deg. and by the reason the Plane is an upright Plane, where there is no Lat. therefore the distance of the Equator from the Pole, being 90 deg. also therefore the new declination will be equal to the height of the Style above the Substyle; therefore if you find the Angle G Æ Z, it will be both the height of the Style, and the Planes new declination; for the finding of which in the Triangle Z G Æ, right angled

angled at G, you have the Planes Reclination Z G, 32 *d.* 11 *m.* and the Angle G Z Æ, the Planes declination, to find the Angle G Æ Z, the new Declination, equal to the height of the Style above the Substyle. Thus;

		d.	*m.*		
As the Radius	90	90	0	10000000	
Is to the Sine of the Declinat. (*viz.*) the Angle G Z Æ,	60	0		9937531	Add
So is the Cosine of the Reclin. Z G,	32	11		9927549	
To the Cosine of the Planes new Declinat.	42	52		9865080	

Which is the height of the Style above the Substyle; also you may find the distance of the Meridian and Horizon, by the same Triangle. Thus;

		d.	*m.*		
As the Cotangent of the Planes Declinat. G Z Æ,	60	0		C.A.0238561	
Is to the Radius	90	0		10000000	Add
So is the Sine of the Planes Reclinat. Z G	32	11		9726644	
To the Tangent of the Arch G Æ,	42	42		9965205	

Which being substracted from 90 deg. leaves the distance of the Meridian and Horizon.

	d.	*m.*
The Latitude of the Place or Height of the Pole P N,	51	32
The Declination of the Plane S D, or N C,	60	0
The Reclination of the Plane Z G,	32	11
The new Latitude wherein it stands as an upright Decliner	0	0
The new Declination in that Latitude, G Æ Z,	42	52
The Distance of the Substyle from the Meridian, Æ R,	90	0
The height of the Style above the Substyle, P R,	42	52
The Planes difference of Longitude, Æ P R,	90	0
The distance of the Meridian and Horizon, A Æ,	47	18

Hence you may see the Planes difference of Longitude, being 90 *d.* the Substyle must be the 6 of the Clock hour-line, and the hour-Angle on either side the hour of 6, are equal; therefore it is but the adding of

of 15 deg. on either side the Substyle, and you will have a Table of hour-Angles, and from thence you may find the hour-Arches, as you were taught in Chap. 9. The Table followeth.

The Geometrical Projection.

Hours from the Substyle. H. S H.	Hour-Angles. d. m.	Hour-Arches. d. m.	Hours from the Substyle. H. S H.
6	Substyle.	Substyle.	6
5 ½	7—30	5—01	6 ½
5—	15— 0	10—20	7—
4 ½	22—30	15—44	7 ½
4—	30— 0	21—27	8—
3 ½	37—30	27—34	8 ½
3—	45— 0	34—14	9—
2 ½	52—30	41—34	9 ½
2—	60— 0	49—41	10—
1 ½	67—30	58—40	10 ½
1—	75— 0	68—30	11—
12 ½	82—30	79—33	11 ½
12—	90— 0	90— 0	12—

The Table being prepared, draw the horizontal Line A C B, near about the middle of the Plane, parallel to the Base, representing A Z B, of the Scheme, in any part thereof, as at C; make the Center; and with the widest of the 60 deg. of the Chord, draw the Circle A D B F, representing the reclining Plane A G B, of the Scheme, from the East-side of the Horizon at A, downwards for the North-part of the Meridian, or (more agreeable to the Scheme) from the West-part at B, upwards, for the South-part; set off the distance between the Meridian and Horizon A D, or B F, 47 d. 18 m. to those Pricks draw the Line F C D, for the hour of 12, from F, Eastwards, because the Declination is West, set the distance between the Substyle and Meridian, which in all Dyals of this kind is 90 deg. and therefore falleth upon the hour of 6, perpendicular to the Meridian, and agreeable to the Scheme in the things desired (*viz.*) B F, to A E; F G, to Æ E, and C F, to Z Æ, the South-part of the Meridian, falling between the West

part

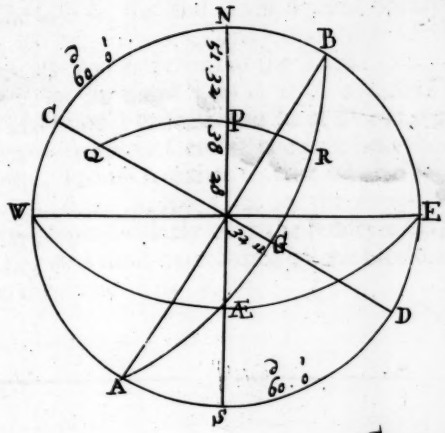
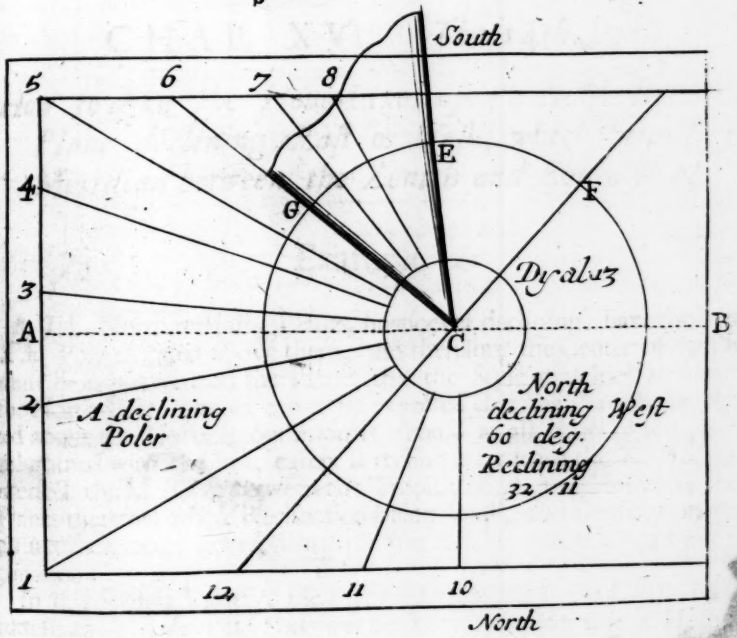
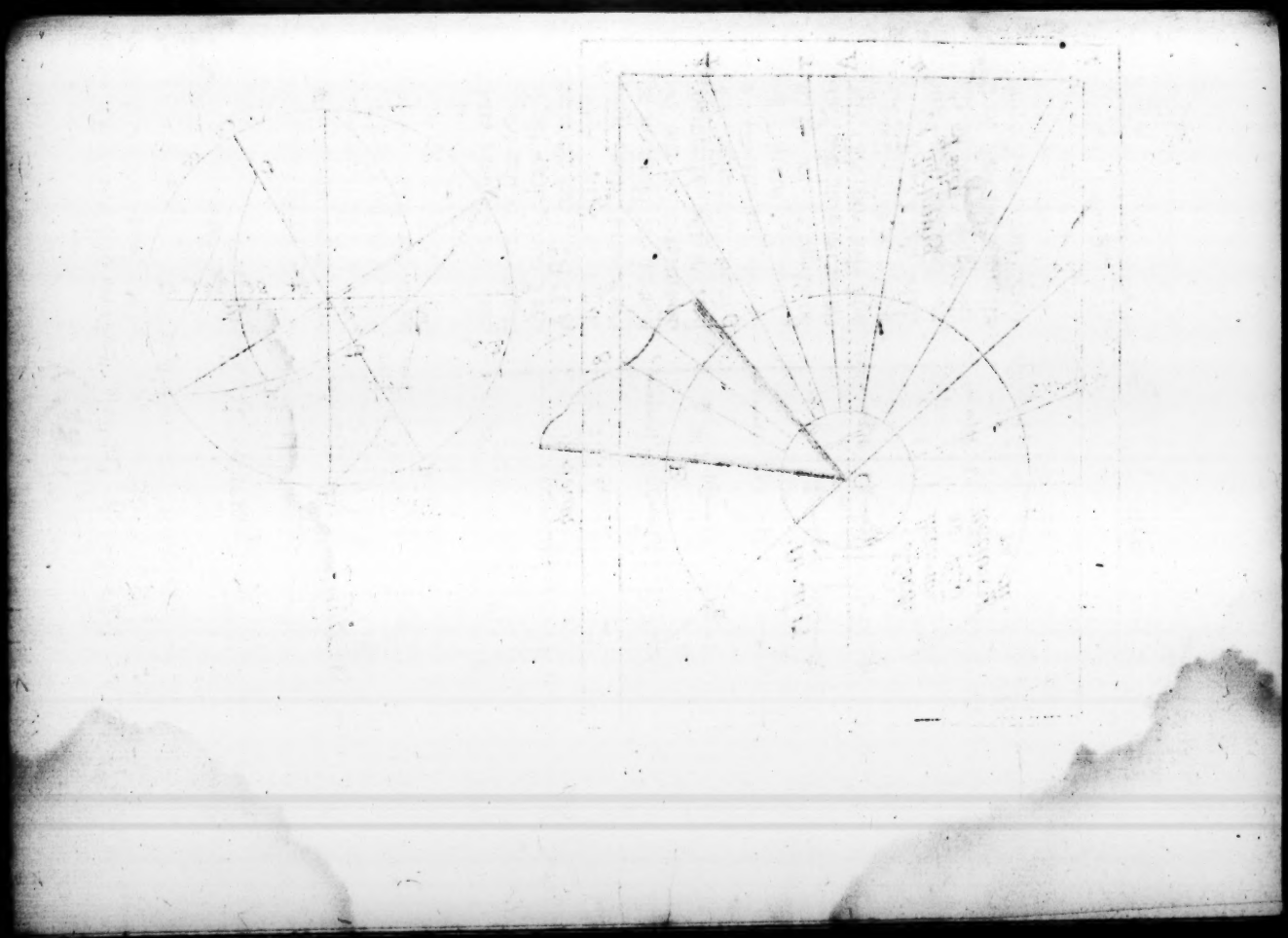

N
B
C
Q
P
R
W
E
G
D
A
S
60°
60°
23½°
32½°

fig: 7


South
5
6
7
8
E
4
F
G
Dyaluz
3
A
B
C
2
A declining
Poler
North
declining West
60 deg.
Declining
32 11
1
12
11
10
North



part of the Horizon and Substyle. Now at the distance of 90 deg. draw the line C G 6, for the hour 6, and Substyle, set off from G, each ways, by help of the Chord) upon the Circle E G A D, the hour-distances, as you find them in the Table (*viz.*) for the hours of 5 and 7, 10 *d.* 29 *m.* for 4 and 8, 31 *d.* 27 *m.* and so of the rest: (But part 8, you need add none) so shall you have Prick, unto which straight lines being drawn from the Center, the true hour-lines are given.

Lastly, From G, either way set off the height of the Style G E, 42 *d.* 52 *m.* and draw the line C E, for the Axis of the World, which being erected perpendicularly over the Substyle G G 6, the Dyal is prepared for Use, and must be rectified by the Declination and Reclination proper to the same.

CHAP. XVI. *The 14th. Dyal.*

How to draw the Hour-Lines upon a North Reclining Plane declining East or West, which cutteth the Meridian between the Zenith and Equinoctial.

Example 2.

ALL North reclining Planes, howsoever declining, have the North Pole elevated above them, and therefore the Center of the Dyal must be so placed upon the Plane, that the Style may look upwards to the North-Pole; neither can it be expected that the Plane being elevated above the Horizon Southwards, should at all times of the year be enlightned with the Sun, except it recline so far from the Zenith, as to interfect the Meridian between the Tropick of ♋, and Horizon; those Planes therefore whose Reclination being small, and Declination great, cannot shew many hours, when the Sun is in his greatest Northern Declination.

In this Second Variety, the Plane represented by the Circle B H A, cutteth the Meridian at Q between the Zenith and Equator Z H, being the reclination 16 deg. and N C the declination of the Plane from the North,

North towards the West P N 60 deg. the height of the Pole, or Latitude of the place, equal to Z Æ, the Equators distance from the Zenith O Æ, is the new Latitude, or Latitude of the Place wherein the Plane stands as an upright Decliner H O Z, the Angle of Declination in that Latitude or new Declination O A, the distance of the Meridian and Horizon O R, the distance of the Substyle from the Meridian, and P R, the height of the Style above the substyle, the Angle O P R, the Planes difference of Longitude, for the new Lat. you have in the Triangle O H Z, right angled at H, you have the Perpendicular Z H, the Planes reclination, and the Angle H Z O, the Planes declination, to find Z O; then the Proportion will be thus;

	d.	m.		
As the Tangent of the Planes Reclin. Z H—	16	0	C. A. 0542504	Add
Is to the Radius—	90	0	10000000	
So is the Cosine of the Planes Declin. H Z O,	60	0	9698970	
To the Cotang. of Z O,	24	50	10241474	

Which being substracted from Z Æ, leaves Æ O, the new Lat.

For the new Declination.

As the Radius—	90	00	10000000	Add
Is to the Sine of the old Declination (*viz.*) the Angle H Z O—	60	0	9937531	
So is the Cosine of the Reclination Z H—	16	0	9982842	
To the Sine of the new Declination, —	50	21	9920373	

For the Distance of the Meridian and Horizon.

	d.	m		
As the Co-tangent of the old Declinat. H Z O.	60	0	C. A. 0238561	Add
Is to the Radius—	90	0	10000000	
So is the Sine of the Planes Reclination Z H—	16	0	9440338	
To the Tangent of H O, —	25	31	9678899	

Whose

Whose Complement, A O, 64 *d.* 29 *m.* is the distance of the Meridian and Horizon; the rest of the parts may be found as formerly, and they will stand thus;

	d.	*m.*
The Latitude of the Place, N P,	51	32
The Reclination of the Plane, Z H,	16	00
The Planes Declination from the North towards the West	60	00
The Planes new Latitude, Æ O	21	42
The new Declination in that Lat.	56	21
The Distance of the Meridian and Horizon, A O	64	29
The Distance of the Substyle from the Meridian, O R,	64	28
The Height of the Style above the Substyle, P R,	30	59
The Planes Difference of Longitude, O P R,	76	10

Having found these things, as you were formerly directed, you may proceed to the making of a Table of Hour-Angles and Arches, as you were formerly directed in the 11th. Chapter, in the Upright Decliner, and it will be as followeth:

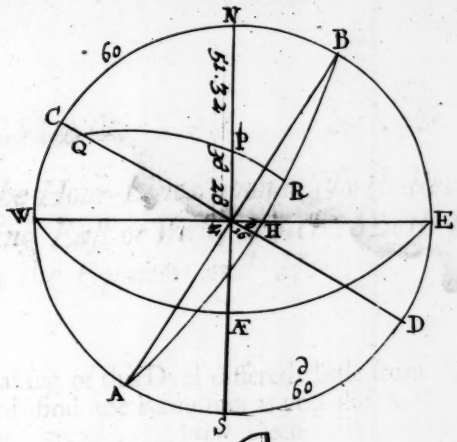
Hours from the Substyle.	*Hour-Angles*		*Hour-Arches.*		*Hours from the Substyle.*
H.	*d.*	*m.*	*d.*	*m*	H.
1	88	50	87	18	11
2	73	50	40	59	10
3	58	50	20	13	9
4	43	50	16	44	8
5	28	50	5	37	7
6	13	50	7	24	6
Substyle.					*Substyle.*
7	1	10	28	36	5
8	16	10	43	29	4
9	31	10	64	18	3
10	46	10	0	12	2
11	66	10	8	5	1
12	76	10	17	26	12

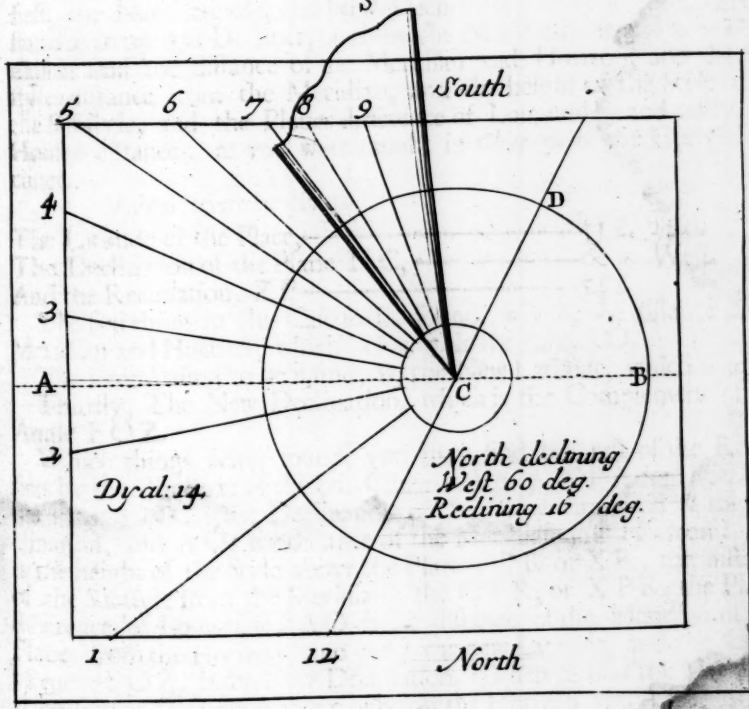
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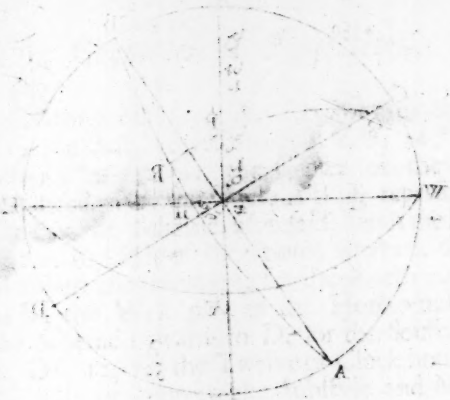
The Geometrical Projection,

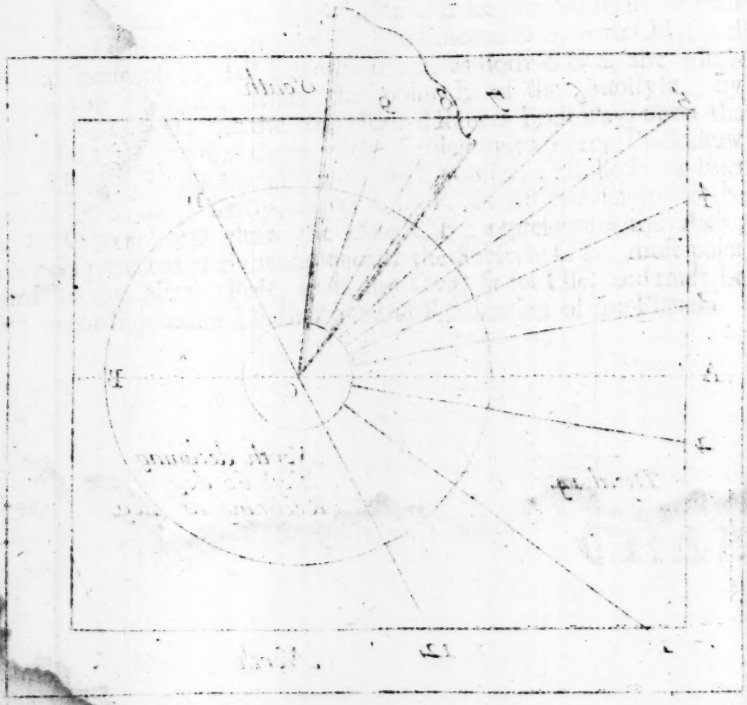
Draw therefore the Horizontal Line A C B, towards the middle of the Plane parallel to the Base, representing A Z B, of the Scheme, in any part thereof; as at C: the Center of the Dyal, and with 60 deg. of the Chord make the Circle A B D, representing A H B, the Reclining Plane in the Scheme aforesaid, from the East Point of the Horizontal Line A (by help of the Chord) set A 12, 64 *d.* 29 *m.* the distance of the Meridian and Horizon, for the North part of the Meridian; but from B, the West part of the Horizontal Line, more agreeable with the Scheme upwards to D, for the South part thereof, and draw the Line DC 12, for the Twelve of Clock hour, from D to E, set 64. 26, the distance between the Substyle and Meridian Eastward from it, and draw the prickt Line C E for the Substyle, so shall B D of the Dyal agree with A O of the Scheme D E, with O R, and C D, the hour of 12, fall between them, as doth Z O S, the Meridian in the Scheme, from the point E of the Substyle, by help of the Chord, set the true Hour-distances both ways upon the Circle A B D, as you find them in the Table: unto every Prick draw streight Lines from the Center C, so shall you have all the Hour-lines proper to this Plane. Lastly, From E to F, set off the height of the Style 30 *d.* 59 *m.* and draw the Line C F, representing the Axis, which being erected at right angles over the Substyle C E, must point upwards to the North Pole, so is the Dyal fit for Use, and must be placed according to the Declination and Reclination of the Plane.

CHAP.


N
B
60
51.32
C
Q
P
23 28
R
W
E
H
D
F
A
60
S


South
5
6
7
8
9
4
D
3
A
B
C
2
North declining
West 60 deg.
Declining 16 deg.
Dyal: 14.
1
12
North


W
A



CHAP. XVII. *The 15th. Dyal.*

To draw the Hour-Lines upon a North Reclining Plane, Declining Eaſt or Weſt, which cutteth the Meridian between the Equator and Horizon.

THE making of this Dyal differeth little from the former; therefore firſt find the Requiſites as you did in the former: that is, firſt, the New Latitude, and New Declination, wherein this Dyal ſhall ſtand as an upright Decliner, and by the New Latitude and new Declination find the diſtance of the Meridian and Horizon, and the Subſtyles diſtance from the Meridian, and the height of the Style above the Subſtyle, and the Planes difference of Longitude; and laſtly, the Houſes diſtance, as you were taught in *Chap.* 9. of the Upright Decliner.

Admit there be given

The Latitude of the Place, ——— 51 *d.* 32 *m.*
The Declination of the Plane N C, ——— 60 *d.* Weſt.
And the Reclination, Z F ——— 54 *d.*

The firſt thing in this Caſe to be found, will be the diſtance of the Meridian and Horizon, which in *Fig.* 7. is the Line A O.

The ſecond thing to be found, is, the New Latitude, which is æ O.

Thirdly, The New Declination, which is the Complement of the Angle F O Z.

Which things being found, you may find the reſt of the Requiſites by the direction of the 9th. Chap. in Fig. 7. N P is the Latitude of the Place. N C is the Declination of the Plane: and Z E is the Reclination, and A O, the diſtance of the Meridian and Horizon: P R, is the height of the Style above the Plane: O R or X R, the diſtance of the Subſtyle from the Meridian: the O P R, or X P R, the Planes difference of Longitude: A O is the diſtance of the Meridian of the Plane from the Horizon, and æ O the new Latitude, and the Complement F O Z, is the New Declination. Then to find the Meridians Aſcenſion or Deſcenſion above or below the Horizon *viz.* A O.

The Proportion will be,

As the Radius or Sine of Z D 90 *d.* ——— 10,00000
Is to the Sine of the Reclination, Z E 54 *d.* ——— 990795
So is the Tang. of the Declinat. of the Plane N C or S D 60 *d.* 1023856

To the tangent of F O 54 *d.* 29 *m.* ——— 1014651

Which 54 *d.* 29 *m.* being ſubſtracted from 90 *d.* leaves A O the diſtance of the Meridian and Horizon.

Then for the New Latitude.

As the ſine of the Planes declination D S, 60 *d.* 00 *m. co ar.* —— 006247
Is to the Radius or Sine of Z S, 90 *d.* ——— 1000000
So is the Sine of the laſt Arch found, F O, 54 *d.* 29 *m.* ——— 991059

To the ſine of Z O, 70 *d.* 2 *m.* ——— 1997306

From which Z O, 70 *d.* 2 *m.* ſubſtract Z a, the Latitude of the place, and there will remain the new Latitude a O, 18 *d.* 30 *m.*

Then for the new Declination in the Triangle Z F O, right angled at F, wherein you have Z F the Reclination, and the angle F Z O, the Planes old declination, to find the angle Z O F, the complement of which to 90 *d.* is the new declination: Thus;

As the Raditus or Sine of 90 *d.* ——— 1000000
Is to the ſine of the Reclination F Z, 54 *d.* 00 *m.* ——— 976922
So is the ſine of the angle F Z O, the old declinat. 60 *d.* 00 *m.* — 993753

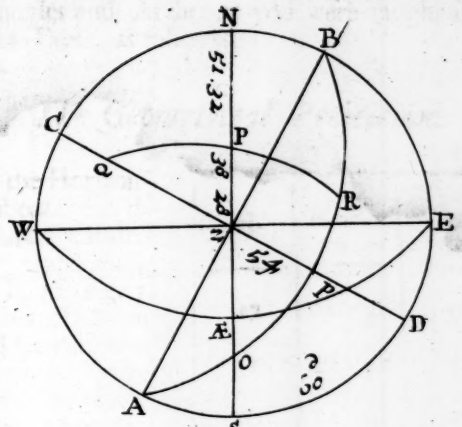
To the co-ſine of the angle Z O F, 59 *d.* 24 *m.* ——— 970675

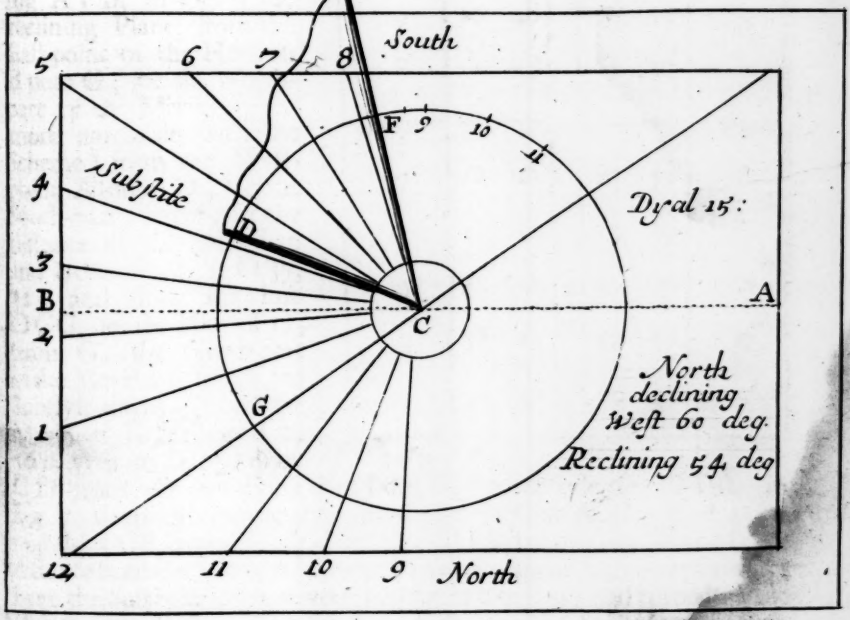
Which 59 *d.* 24 *m.* being ſubſtracted from 90 *d.* leaves 30 *d.* 36 *m.* for the Planes new declination, wherein it doth ſtand as an upright Decliner. The reſt of the Parts that are to be found, are to be found as they be in all, upright Decliners. And will be as follow:

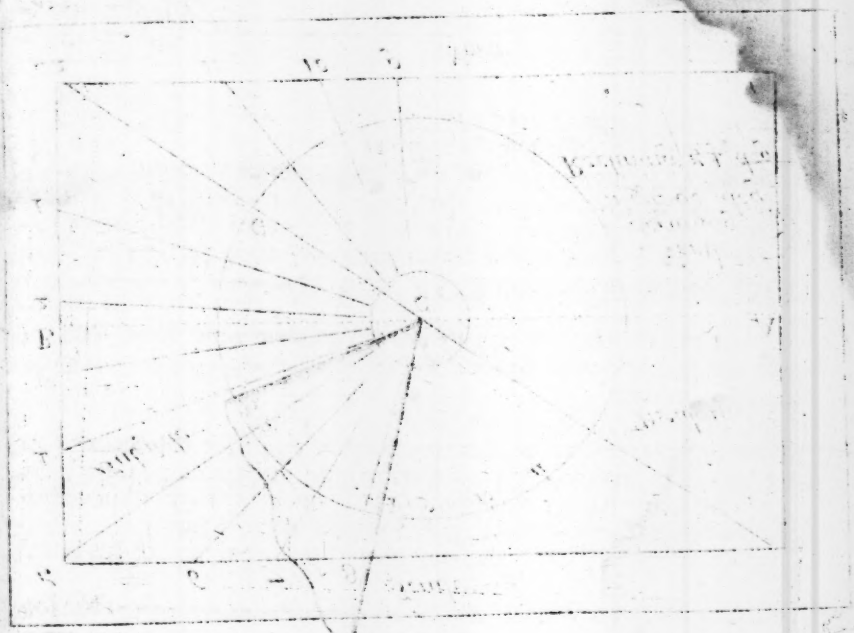
The height of the Style P R, 54 *d.* 43 *m.*
The Subſtyles diſtance from the Meridian, ——— O R, — 123 19
X R, — 56 41

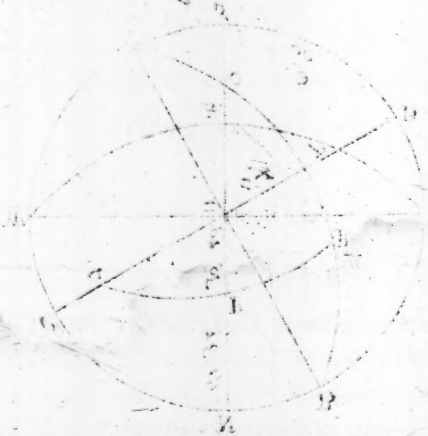
The Planes difference of Long. ——— O P R — 118 13
X P R — 61 47

Having


N
B
51.32
C
P
38
24
R
W
E
54
D
A
S
30


South
5
6
7
8
F
9
10
11
4
Substile
Dyal 15:
3
B
A
2
C
North
declining
West 60 deg.
1
G
Reclining 54 deg
12
11
10
9
North





Having the Planes difference of Longitude, you may frame a Table of Hour-angles and Arches as you were taught in Chap. 9. and place them in a Table, as followeth:

The Geometrical Projection.

H.	*Hour-Angles.*		*Hour-Arches.*		H.
12	61	48	56	41	12
11	46	48	40	49	1
10	31	48	26	50	2
9	16	48	13	50	3
8	1	48	1	27	4
Substyle.					*Substyle.*
7	13	12	10	51	5
6	28	12	23	39	6
5	43	12	37	29	7
4	58	12	52	48	8
3	73	12	69	43	9

First, Draw the Horizontal line ABC, about the middle of the Plane, parallel to the Base, representing the line A Z B, in Fig. 7. in any part thereof: as at C, the placed Center, and and with 60 degrees of your line of Chords, make the Circle A D F B, representing A F B, in Fig. 7. the reclining Plane, from the East point of the Horizon B unto G, for the North-part of the Meridian, or more agreeable with the Scheme) from the West-point A unto O, for the South-part thereof, set the distance of the Meridian and Horizon, *viz.* A O 35, 31, and draw the line O C G, for the hour of 12, from G, the North-part of the Meridian, set off the Substyle-distance from the Meridian R X, equal to 56 *d.* 41 *m.* to D, and draw C D from the Substyle: then from D, the Substyle, set off P R, in Fig. 7. the height of the Style, above the Substyle equal to 54 *d.* 43 *m.* and draw C F, representing the Axis of the World; then set the hours distance from the Substyle, as you find them in the Table, both ways from the Substyle, (as you were taught in Chap. 9.) and through these Points draw lines, and set the Style right over the Substyle; and then have

have you finiſhed four ſeveral Dyals: this for one, and his oppoſite South-inclining to the Horizon 36 deg. and declining Eaſterly 60 deg. as alſo the North reclining 54 deg. and declining Eaſterly 60 deg. and his oppoſite South inclining to the Horizon 36 deg. and declining Weſterly 60 deg. only turning the Dyals up and down Styles and all, and changing the Figures of the hours for Forenoon and Afternoon, as the Nature of the Dyal will direct you; and ſo may be done to all Dyals whatſoever except the Eaſt and Weſt; for there can be but two Dyals; for the backſide of the Eaſt is a Weſt Dyal.

CHAP. XVIII. *The 16th. Dyal.*

Of the manner of cutting divers Bodies in Wood or Stone, and making Dyalls upon them.

THere are ſeven Bodies uſually cut in Stone or Wood, whereof five of them are called *Regular Bodies*, becauſe they may be inſcribed in a Sphere (and are demonſtrated in the 14. Book of *Euclid*) which are the *Cube*, the *Tetrahedrum*, the *Octohedrum*, the *Dodecahedrum*, and the *Icoſahedrum*; the other two are thoſe of Twelve and Thirty *Rhombs*, deviſed by Mr. *Henry Briggs*: And becauſe the Cube is the Mole or Lump out of which the reſt are contrived, it will be needful that the *Cube* be firſt deſcribed.

How to cut the Cube.

A *Cube* is a ſolid Body, comprehended by ſix equal Squares, as are A B C D, A D E F, and D C F G, *&c.* The cutting of this Body is plain by the Definition; for let every ſide of every Square be equal, as A B, to D E, A E to C G, *&c.* and you make a *Cube* of what greatneſs you will; this Body is capable of five ordinary Dyals, the ſixth ſquare being the Baſe to ſtand upon: wherefore if you ſet the ſide A D E F, South, then will the ſide oppoſite thereto be North, D C F G, Eaſt, and the ſide oppoſite thereto Weſt, and A B D C, Horizontal: all which Dyals are already made in the foregoing 5th. 6th. and 7th. Chapters. But if you place any angle of the Horizontal Square South, then will every ſide decline 45 deg. for if the angle D be placed South,

then

then will the Diagonal Line A C be East and West, which Diagonal doth divide the angle A and C, into two equal parts, and the whole Square, A B C D, is also divided into equal parts by the Diagonal A C, and doth make thereof two right angled Triangles, viz. the right angled Triangle A D C, and A B C, and the three angles of any plain Triangle are equal to 180 deg. by 32 of 1 *Euclid*, and the angle D is 90 deg. by the Work, therefore the angle A and C subtended by equal sides, are 45 deg. apiece; and consequently each side declineth from the Line A C, 45 deg. wherefore D C F G is a South-Decliner East 45 deg. and A D F E a South-Decliner West as much, and their Opposites North-declining East and West 45 deg. all which four Dyals are in effect made in the Ninth Chapter, observing the Cautions therein mentioned.

How to cut the Tetrahedrum.

The *Tetrahedrum* is a solid Body comprehended by four equal equilateral Triangles, as are A C B, A C D, and D C B: to cut this Body, you must first make a Parallelpiped. Let the Breadth A D be $\frac{10000}{10000}$, and the Heighth A E, the Root of $\frac{8}{10000}$, and the Length A B the Root of $\frac{8}{10000}$, upon the upper face and base thereof draw two opposite equal Triangles, as is A D H, divide the Perpendicular thereof P H equal to A B, or D C into three equal parts; let the third part thereof $\frac{8}{10000}$, from A to N, and from D to L, draw the Line N L in the middle thereof at the Point K, which will be the Vertex of the Solid A B D: from the point L, to the angles F and G, draw two straight lines L F and L G: do the like on the opposite side by the point N: cut off the the two triangular portions L D F, N A H, and G L C, N B, so will remain the solid Body called a Prism, whose two sides F L G, and the opposite are equal Triangles, the other three sides, L F N E, &c. are Parallelograms. Next by the points F K H, and the side of the Triangle F H, drawn in the base, as also by the points E K H, and the other side of the Triangle E H, cut this Prism, and there will come forth the solid Body A C D B, the *Tetrahedrum* desired. The Body being thus prepared, set the angle A South, then will the side B C D, be a North declining 19 *d.* 28 *m.* 16 *sec.* and the other two sides A C B and A C D, will be South declining 60 deg. and and will recline as the former. The manner of making these Dyals, is shewed in the foregoing Chapter.

The Hour-Distances from the Meridian are as followeth:

Hours

Hours from the Merid.	*Hour-Arches on the Plane.*
12	00
11— 1	12—48
10— 2	27— 4
9— 3	40—17
8— 4	55—44
7— 5	72—28

North reclining——19—28—16
The complement of the Latitude add.—38—28—00
Height of the Style.—57—56—16

The other two South declining reclining have the same Dyal serving for both; changing but the Position of the Substyle and Hours, as the Cautions of the 14th. Chapter will direct you.

The Requisites and the Hours-distance from the Substyle, are as followeth:

The Plains Reclination is——19 28 16
The Plains Declination East and West, is——60 00 00
The distance between the Meridian and Horizon is——60 00 00
The height of the Style above the Plane——1 50 53
The Substyles distance from the Meridian——2 36 56
The Plains difference of Longitude——34 40 43
Therefore the Substyle falleth between 8 and 9 of the Clock in the East, and between 4 and 3 in the West.
The Sine of 1 *d.* 50 *m.* 53 *sec.* is——8,508170.

Hours

Hours from the Subſtyle.	*Ho. Ar. on the Plane.*	*Hours from the Subſtyle.*
3	10—36	9
4	4—00	8
5	2—13	7
6	1—18	6
7	0—41	5
8	0—10	4
Subſtyle.		*Subſtyle.*
9	0—19	3
10	0—52	2
11	1—32	1
12	2—37	12
1	5—00	11
2	19—26	10

How to cut the Octohedrum.

The *Octohedrum* is a ſolid Body, comprehended of eight equal equilateral Triangles, as are A C B, A C D, B C E, and E C D: To cut this Body, you muſt firſt make a Parallellepiped B E F C, let the breadth thereof B C, or A D be 10^{0000}, and the heighth thereof A E, or C G, be the Root $\frac{3}{4}$; as before, 8$\frac{1649}{}$, and the length thereof B A, or F G, the Root of $\frac{4}{4}$, more by $\frac{1}{4}$ thereof 11$\frac{5470}{}$, let A I, and D K, and L G, be 2$\frac{8867}{}$, one fourth of A B, or F G, ; by which draw the

Line

Line I K, upon the Superficies, and the like by L in the Baſe, make two equilateral Triangles I K H, upon the ſuperficies, and from the point L in the baſe the like; ſo that the point N of the Triangle in the baſe may be oppoſite to the point H of the ſuperficies: draw the lines K F, K L, and L C on the ſide of the Figure, and the like on the other ſide; cut off the triangular portions I K F E downwards, and the oppoſite to it L G C B upwards, and there will remain two equal Oblongs, K I B H C, and L F N E, the baſe inclining from the line B H C, as much as the ſuperficies doth recline from the Perpendicular of E N F. Next cut off the portions L K H and I H above, and L K N and I N by the Triangle beneath, ſo ſhall you have at ſix Cuts the ſolid of eight equilateral Triangles A B C D E deſired. The Body thus prepared, ſet the angle C of the horizontal A C B ſouth, and the ſame Dyal of the *Tetrahedrum* will ſerve for the *Octohedrum* alſo; for the Plain D C E will be a South inclining, and his oppoſite a North reclining 19 *d.* 28 *m.* 16 *ſec.* and the Plane D C A and E C B will decline 60 deg. and recline as the other, and their oppoſites decline and incline as much, as may be ſeen by the bodies themſelves, joyning the reclining ſide B C D of the *Tetrahedrum* to the inclining ſide D C E of the *Octohedrum*, will plainly demonſtrate the ſame, the Dyals being the one and the ſame in both, there will not be any need to reiterate the work over again.

How to cut the Dodecahedrum.

The *Dodecahedrum* is a ſolid Body, comprehended of 12 equilateral Pentangles, as are H S R V O, H S B A, and H O E A, *&c.* To cut this Body, you muſt firſt make a Cube: as is p r s v; divide each ſide into halves, as p q at a b, r s at f e, and x p at c d: let each half p a, p e, and r f be the Radius, or 10^{0000} divided by extream and mean proportion p g, x h, and p o ſhall be 6^{1803}, the greater ſegment, and g c h e and N b 3^{8196} the leſſer ſegment; and ſo muſt the reſt of the ſide be alſo divided, but with this caution, that the middle lines and ſegments of every ſide conterminous be drawn croſs to other, as thoſe of p q, r p, croſs to thoſe of x r s v; and they again croſs to them of P X, V Z, yet every oppoſite ſide parallel to other; from the greater ſegment of one ſide to the middle line of the other draw ſtreight lines croſs the Body, as are n c k c, and h b: cut off each triangular Priſma, (*viz.*) n o d e l k f e, and m h b a; and ſo of the reſt. So ſhall you at 12 Cuts frame the *Dodecahedrum*, conſiſting of 12 pentangles, as is repreſented by the Figure: The Body being thus prepared,

ſet

ſet the angle H, of the Horizontal Plane HRSVO, South; then ſhall the five ſuperior planes recline, and their oppoſites incline as much, (*viz.*) R V D K C will be a direct North reclining 26 *d.* 33 *m.* 54 *ſec.* and V O D E and R S B C, two North reclining as much, and declining alſo 72 deg. H O E A and H S B A, two South reclining as much, and declining alſo 36 deg, the reclination of all five being the ſame.

Having the reclination of the North-Plane, the Dyal is to be made as you are taught in the Eighth Chapter; whoſe Hours-diſtances from the Meridian, are as followeth:

	d.	*m.*	*ſec.*
V R D C, the North-reclining plane	26	33	54
The Complement of the Latitude, Add.	38	28	00
The heighth of the Style will be	65	01	54
The Sine of this 65 1 54, is	9957	3875	

Hours from the Merid.	*H. Arc. on the Plane.*
12—00	00—00
11—01	06—40
10—02	13—39
09—03	20—35
08—04	27—38
07—05	34—49
	42—12
	49—45
	57—30
	65—00
	73—32
	81—44

The two North-Recliners and their Oppoſites declining 72 deg. have the ſame Dyal ſerving for all four, changing the poſition of the Style and Hours, as before was directed; and are to be made by the Rules of the foregoing Chapters: the Particulars whereof, with the Hour-diſtance, are as followeth:

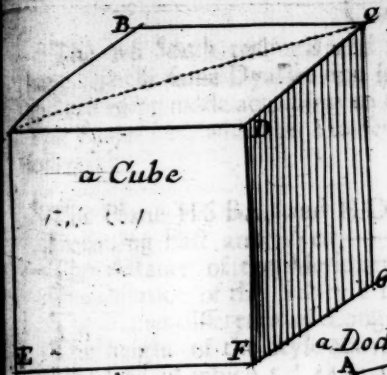
R S B C,

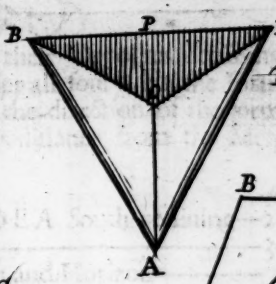
	d.	m.	sec.
RSBC, and VODE, North reclining	26	33	54
Declining also East and West	72	00	00
The distance of the Meridian from the Horizon, is	36	00	00
The distance of the Substyle from the Meridian	82	04	40
The Planes difference of Longitude	85	50	41
The heighth of the Style above the Substyle	31	28	20

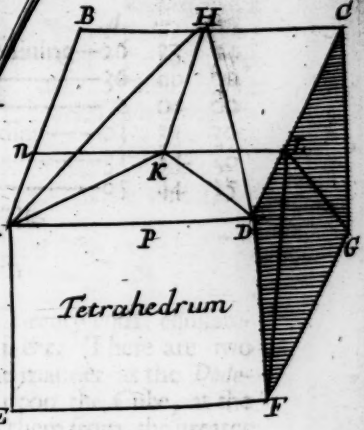
The sine of which 31 *d.* 28 *m.* 20 *sec.* is 97177414. The Table of Hours and Hour-Arches follow.

Hours from the Substyle.	*H. Arch on the Plane.*
12	82 05
	68 26
11 01	56 22
	46 08
10 02	37 35
	30 25
03 09	24 18
	18 58
04 08	14 12
	09 49
05 07	05 43
	01 42
Substyle	*Substyle*
06 06	02 10
	06 09
07 05	10 17
	14 41
08 04	19 30
	24 55
09 03	31 07
	38 26
10 02	47 09
	57 35
11 01	69 51

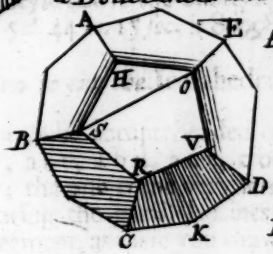
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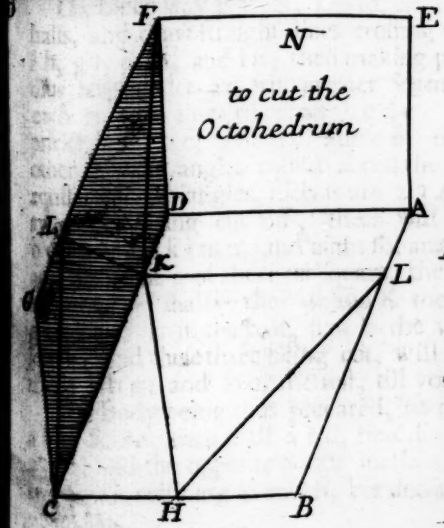

B
C
D
a Cube
E
F
G

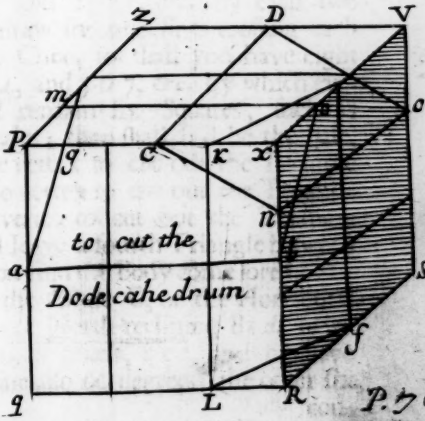

B
P
D
Tetrahedrum
A


B
H
C
n
K
A
P
D
G
Tetrahedrum
E
F


Octohedrum
B
C
E


a Dodecahedrum
A
E
H
o
B
s
V
R
D
C
K


F
E
N
to cut the
Octohedrum
D
A
K
L
C
H
B


z
D
V
m
c
P
q
C
k
x
n
to cut the
Dodecahedrum
a
s
f
q
L
R

P. 76

Tetraedrum
A
Cubus
Octaedrum
Dodecaedrum
Icosaedrum

The two South reclines and their Oppoſites declining 36 degrees, have alſo the ſame Dyal ſerving for all four with the former Cautions, and are to be made according to the direction of the former Chapters. The Requiſites, with the Houſes diſtance from the Meridian, are as followeth:

	d.	*m.*	*ſec.*
The Plane H S B A, and H O E A South reclining	26	33	54
Declining Eaſt and Weſt	36	00	00
The diſtance of the Meridian and Horizon	72	00	00
The diſtance of the Subſtyle from the Meridian	03	33	36
The Planes difference of Longitude	31	53	40
The height of the Style above the Subſtyle	05	44	15

The ſine of which 5 *d.* 44 *m.* 15 *ſec.* is 89998739.

How to cut the Icoſahedrum.

The *Icoſahedrum* is a Solid comprehended of twenty equal equilateral Triangles, as are, a b c, a b d, a c e, c b f, *&c.* There are two ways to cut this Body; the one is the very ſame manner as the *Dodecahedrum* was cut, drawing the parallel Lines upon the Cube, at the diſtance of the leſſer Segment, as there you draw them from the greater Segment.

The other way is thus; Divide each ſide of the Cube p q r s v into halfs, and draw ſtraight lines croſſing at right angles, as are b d, c e, f h, g l, k m, and l n; then making p o or o a, half the ſide, the Radius 10$\overline{0000}$, let a c, the greater Segment 6$\overline{1803}$ be ſet from a, upon each middle line to croſs b c d e, and f g h i, *&c.* by each two pricks (*viz.*) b e, c d, b c, and e d, draw ſtraight lines croſſing each other at right angles round about the Cube, ſo ſhall you have eight equilateral Triangles, ſuch as are 2 3 4, and 5 6 7, *&c.* by which every corner being cut off, there will remain ſix Squares, ſuch as b c d e f g h i k l m n, and eight ſix angles; then ſhall b d be the baſe, and the point g of the next ſquare, the vertex to cut out the Triangle b d g and g i ſhall be the baſe and K the vertex to cut out the Triangle g i k, and k in the baſe, and b the vertex to cut out the Triangle k m b, and theſe three being cut, will leave a fourth Triangle between them k b g; and ſo of the reſt, till you find the Body come forth.

The Body being thus prepared, ſet the Angle C, of the Horizontal a b c, South, then ſhall a b d, be a direct North reclining 81 *d.* 11 *m.* 23 *ſec.* and the oppoſite South inclining as much, a c e, and c b f are two South reclining as much, but decline alſo 60 degrees: the other ſix

con-

conterminous with these three, do all recline alike 19 *d.* 28 *m.* 16 *sec.* whereof the two South g c e, and g e f, do also decline 22 *d.* 14 *m.* 29 *sec.* the two backward Northern Planes k b d, and h a d, do decline 37 *d.* 45 *m.* 41 *sec.* and the two intermediate North planes b k f, and a h e do also decline 82 *d.* 14 *m.* 19 *sec.* and as these do, so do their opposites decline and incline as much. These things being considered, and the Body being prepared, the North reclining Dyal 48 *d.* 11 *m.* 23 *sec.* will be made according to the Rules of the Eighth Chapter, whose hour-distances from the Meridian, are as in the following Table.

	d.	*m.*	*sec.*
d b a the North reclining plane	48	11	23
The compl. of the Lat. of the Place, add.	38	28	00
Their sum will be the height of the style above the Plane.	86	39	23

The Sine of which 86 *d.* 39 *m.* 23 *sec.* is 99992600

Hours from the Merid.	*Hour-Arches on the Plane.*
12	00—00
½	7—29
11— 1	14—59
½	22—28
10— 2	29—57
½	37—27
9— 3	44—57
½	52—27
8— 4	59—57
½	67—28
7— 5	74—59
½	82—29
6— 6	90—00

The other two South reclining as much, and declining also 60 deg. (*viz.*) b e f, and a c e, have the same Dyal serving for both, changing the

the position of the Substyle and Hours, as afore-directed: The Particulars whereof, with the Hour distances from the Substyle, are as followeth:

	d.	m.	sec.
b c f, and a c e, South reclining	48	11	23
Declining East and West	60	00	00
The distance of the Meridian and Horizon	37	45	41
The Substyle-distance from the Meridian	16	41	31
The Planes difference of Longitude	38	32	50
The height of the Style above the Substyle	22	06	03

The hour-Arches on the Plane, are as in the Table following.

Hours from the Substyle.	Hour-Arches.	Hours from the Substyle.	Hour-Angles
Substyle.	° ′	Substyle.	° ′
¼	00—24	09—03	02—26
10—02	03—14	¼	05—20
½	09—11	08—04	08—25
11—01	09—19	½	11—45
¾	12—46	07—05	15—32
12—12	16—42	¾	19—56
½	21—19	06—06	25—17
01—11	27—00	½	32—00
¾	34—13	05—07	40—48
02—10	43—45	¼	52—36
¼	56—34	04—08	68—13
03—09	73—16	½	87—12

The two South reclining 19 *d.* 28 *m.* 16 *sec.* (*viz.*) g e f, and g c e, do also decline 24, 14, 19, and are to be made by the Rules of the foregoing Chapters; the Particulars whereof are as followeth:

	d.	m.	sec.
g f e, and g e c, south reclining	19	28	16
Declining East and West	22	14	19
The distance of the Meridian and Horizon	82	14	19
The distance of the Substyle from the Meridian	06	26	34
The Planes difference of Longitude	21	49	56
The Styles height above the Substyle	16	22	19

The Hour-Arches are as is in the following Table. Hours

Hours from the Substyle.	Hour-Arches.	Hours from the Substyle.	Hour-Arches.
Substyle.		Substyle	
11 01	01 56	½	00 11
½	04 07	10 02	02 19
12 12	06 27	⅓	04 32
⅓	09 00	09 03	06 53
01 11	11 55	¼	09 26
⅔	15 24	08 04	12 30
02 10	19 44	⅔	16 06
½	25 26	07 05	20 37
03 09	33 22	¾	26 38
½	45 09	06 06	35 08
04 08	63 01	½	47 49
½	87 38	05 07	66 58

The two middle Planes North reclining as much, f k b, and e h a do alſo decline 82 *d.* 14 *m.* 19 *ſec.* The Particulars as followeth:

	d.	*m.*	*ſec.*
k f b, and a e h north reclining	19	28	16
Declining Eaſt and Weſt	82	14	19
The diſtance of the Meridian and Horizon	22	14	19
The diſtance of the Subſtyle from the Meridian	71	17	00
The Planes difference of Longitude	83	25	34
The height of the Style above the Subſtyle	19	53	19

The Table of hour-arches are as in the following Table:

Hour-

Hours from the Substyle.	Hour-Arches.	Hours from the Substyle.	Hour-Arches.
Substyle		Substyle.	
	00 19	06 06	02 15
05 07	02 53		04 53
	05 33	07 05	07 40
04 08	08 23		10 43
	11 33	08 04	14 10
03 09	15 06		18 14
	19 21	09 03	23 13
02 10	24 38		29 35
	31 38	10 02	38 08
01 11	40 42		50 01
	53 37	11 01	66 26
12 12	71 17		87 17

The other two North-reclining as much (*viz.*) k b d and h a d, do ~~also decline~~ 37 *d.* 45 *m.* 41 *sec.* ~~and are to be made by the Rules of~~ the former Chapters: the Particulars whereof, with the Hour-distances from the Substyle, are as follow.

	d.	*m.*	*sec.*
k d b, and h d a, North reclining	19	28	16
Declining East and West	37	54	41
The distance of the Meridian and Horizon	75	31	21
The distance of the Substyle from the Meridian	48	02	04
The Planes difference of Longitude	56	45	32
The Styles height above the Substyle	56	54	32

Hours from the Substyle.	Hour-Arches.	Hours from the Substyle.	Hour-Angles
Substyle.		Substyle.	
½	03—12	08—04	02—14
09—03	08—41	½	07—43
½	14—19	07—05	13—19
10—02	20—12	⅔	19—09
½	26—24	06—06	25—17
11—01	33—01	⅔	31—50
½	40—13	05—07	38—55
12—12	48—08	⅔	46—37
½	56—32	04 08	55—00
01—11	65—44	½	64—04
½	75—32	03—09	73—46
02—10	85—44	½	83—55

How to cut the Body of Twelve Rhombs.

The Thirty first Definition of *Euclid* defineth a *Rhomb* to be a *Parallelogram*, or a Figure consisting of four equal Sides, but hath unequal Angles; as out of the Figure a b c d of this Plane may be composed two bodies, one consisting of twelve Rhombs, as is the Figure a b c k h n d, and the other of thirty. To cut the body of twelve Rhombs, make a Parallelepiped, as is a b g f; let the length be to the breadth or depth as 1 to the Root of ½, so shall a h or c g be 10^{000}, the breadth and depth of a d f g, equal to 7^{0710}, divide the length into equal parts at n l 1; from these points draw lines to the angles, and they shall include four Rhombs, as are m i k l, and l p n r, *&c.* Draw upon each end two diagonal lines, a c and b d, which joyning at each angle with the lines drawn from the middle points, shall make triangles, such as is a l c, *&c.* cut away each corner by these triangles, (*viz.*) d, by the triangle a l c and t, by the triangle g l h; and so of the rest; so shall you at eight cuttings, frame the body of 12 Rhombs, such as in the Example appeareth.

The

The body being thus prepared, ſet the angle c, of the Horizontal Rhombs a b c d ſouth, then will f h g c be a direct ſouth, and his oppoſite a direct north Dyal; the other are all declining alike; whereof the four uppermoſt do recline 30 deg. and their oppoſites do incline as much; and each doth decline 54 *d.* 44 *m.* 8 *ſec.* Eaſt and Weſt; therefore any two Dyals being made, will ſerve for all the reſt (except the ordinary North and South, and Horizontal) the manner of making the declining reclining Dyals are ſhewed in the former Chapter.

The Particulars whereof. with the diſtances of the Hours from the Subſtyle, are as followeth:

	d.	*m.*	*ſec.*
The planes adjacent to the ſides of the Horizontal b a, a d, are North reclining	30	00	00
Declining Eaſt and Weſt	54	44	08
The diſtance between the Meridian and Horizon	54	44	08
The height of the ſtyle above the ſubſtyle	44	37	44
The Subſtyle-diſtance from the Meridian	80	47	51
The Planes difference of Longitude	83	30	24

Hours from the Subſtyle.	*Hour-Arches on the Plane.*	*Hours from the Subſtyle.*	*H. Arc. on the Plane.*
½	00—42	06—06	04—34
7— 5	6—00	½	09—56
½	11—24	05—07	15—27
8— 4	16—59	½	21—16
½	22—53	04—08	27—28
9— 3	29—12	½	34—09
½	36—02	03—09	41—26
10— 2	43—31	½	49—27
½	51—44	02—10	58—14
11— 1	60—44	½	67—47
½	70—28	01—11	77—59
12 12	80—48	½	88—34

The other two Planes adjoyning to the Horizontal Plane, are the Planes b c f e, and d c g i, which are South reclining — 30 00 00
Declining East and West — 54 44 08
The distance of the Meridian from the Horizon, is — 54 44 08
The height of the Style above the Substyle — 04 36 53
The distance of the Substyle from the Meridian — 04 37 48
The Planes difference of Longitude — 45 11 09

Hours from the Substyle.	H. Arch on the Plane.	Hours from the Substyle.	H. Arch on the Plane.
09 03	00 00	½	00 36
¾	00 11 37	08 04	01 13
10 02	01 15	¼	01 53
½	1 55	07 05	02 38
11 01	2 40	¾	03 30
¾	03 33	06 06	04 34
12 12	4 38	½	05 57
¼	6 01	05 07	07 52
01 11	8 00	¾	10 54
¾	11 05	04 08	16 31
02 10	16 35	½	30 49
		03 09	87 43

To cut the Body composed of 30 Rhombs.

This Body is represented by the Figure L Z A E, is somewhat more troublesome to cut than the former, and is framed out of the Cube a m g k, dividing every side thereof by extream and mean proportion, which is thus easily done; Let a b, b g, b m, *&c.* be 10^{0000}, then shall a c, b d, b n, m h, b f, g e, *&c.* be 6^{1800}, the greater Segments, which take off the Sector opened to the widest of any sides, and set from each angle a, b, g, m, *&c.* both ways, shall leave a d, b c, b h, m n, b e, g f, *&c.* 3^{8100}, the lesser Segments of the same sides, from the Terms of the greater Segments on the one side,

to

to the leſſer on the other ſide, draw parallel lines, as are d e, a f, b g, and q i, croſs them with the like parallel lines, as are c l, b q, e k, and f p, from each oppoſite angle b k, and a g, unto the leſſer ſegments oppoſite to the ſaid angle, draw parallel lines, as are a b, g c, b i, and k d; ſo have you all the lines on this ſide the Cube neceſſary for direction in cutting of this Body; and thus muſt you do with all the reſt of the ſides: The lines being drawn as you ſee in the Figure, there are three Triangles framed about every ſolid angle, as are the prickt lines a f h, m d e, and g n c, about the angle b, by which that angle muſt be three times cut (continuing each line as a part is cut away, to avoid confuſion) ſo ſhall you at 24 cuts produce the Body of 30 Rhombs, the thing deſired; which being prepared, ſet the acute angle N of the Horizontal Rhombs thereof N M L R, South, then ſhall the Rhomb O P Q R be South alſo, and his oppoſite North, A B C D of the Cube (being the ſame in the body) Weſt, and his oppoſites Eaſt; the reſt are all South and North declining reclining: and as the three Rhombs O P N T, T N R X, and T X Z O, which are conterminous with the Horizontal South and Weſt Planes do decline and recline, ſo do all the reſt, as from the very inſpection of the Body doth ſufficiently appear: wherefore having found the Declination and Reclination for theſe three Planes, there is as much done as is needful for this Body; then will you find that O P N T, and K P N C will be two reclining Planes, reclining 30 degrees, and declining Eaſt and Weſt 20 *d.* 54 *m.* 18 *ſec.* and T N R X, and C N M D will be South reclining Planes, reclining 54 deg. and declining 56 *d.* 16 *m.* 57 *ſec.* and O T X Z, and K C D E, ſouth reclining Planes, reclining 18 deg. and declining Eaſt and Weſt 58 *d.* 16 *m.* 57 *ſec.* the three North ones will be the ſame with the South in all reſpects, both for Reclination and Declination; by which means you will have 24 declining re-inclining Dyals, whereof three will be South reclining Dyals, declining Eaſt, and three will have the ſame declination Weſt, and will decline as much, and ſo there will be of the North reclining Dyals, and each Dyal hath its oppoſite, which doth incline and recline as much, and there will be five ordinary Dyals (*viz.*) a horizontal one, a South one, an Eaſt and Weſt one, and a North Dyal; ſo will you have 29 Dyals on this Body. The manner of making of theſe Dyals is ſhewed in the foregoing Chapter; the Requiſites and the hour-Arches on the Plane are as followeth:

O P N T

	d.	m.	sec.
The Planes O P N T, and K P N C South reclining	30	00	00
Declining East and West	20	54	18
The distance of the Meridian and Horizon	79	11	16
The height of the Style above the Substyle	06	25	03
The distance of the Substyle from the Meridian	02	05	40
The Planes difference of Longitude	18	07	05

Therefore the Substyle stands between 10 and 11 of the Clock in the East Dyal, and between 1 and 2 in the West Dyal.

The Table of Hour-Arches is as followeth:

Hours from the Substyle.	*Ho. Ar. on the Plane.*	*Hours from the Substyle.*	*H. Arc. on the Plane.*
Substyle.		*Substyle.*	
11 01	00 21	½	00 20
½	01 12	10 02	01 21
12 12	02 06	½	02 15
½	03 04	09 03	03 15
01 11	04 10	½	04 22
½	05 28	08 04	05 43
02 10	07 06	½	07 26
½	09 17	07 05	09 43
03 09	12 26	½	13 07
½	17 37	06 06	18 52
04 08	27 59	½	30 48
½	55 23	05 07	64 02

The South Plane T N R X doth decline west 58 *d.* 16 *m.* 57 *sec.* and doth recline 54 deg. and are made as formerly directed. The Requisites are as follow.

	d.	m.	sec.
T N R X are South reclining	54	00	00
Declining East and West	56	16	57
The distance of the Meridian and Horizon	37	22	38
The height of the Style above the Substyle	26	10	52
The distance of the Substyle from the Meridian	16	29	25
The Planes difference of Longitude	33	51	33

By which means the Substyle falls between 9 and 10 of the Clock in the East, and between 2 and 3 in the West Decliner.

The Table of hour-arches is as followeth:

Hours from the Substyle.	H. Arc. on the Plane.	Hours from the Substyle.	Hour-Arches.
Substyle.		Substyle.	
10 02	01 42	½	01 36
½	05 04	09 03	04 58
11 01	08 34	½	08 28
½	12 20	08 04	12 13
12 12	16 30	½	16 22
½	21 14	07 05	21 04
01 11	26 48	½	26 38
½	33 33	06 06	33 19
02 10	41 58	½	41 42
½	52 37	05 07	52 14
03 09	65 58	½	65 32
½	81 48	04 08	81 17

The South Plane O T X Z declining West, 58 *d.* 16 *m.* 57 *sec.* doth also recline 18 deg.

The Requisites and Table of Hour-Arches are as followeth:

	d.	m.	sec.
OTXZ, and KCDE are South reclining	18	06	00
Declining East and West	58	16	57
The distance of the Meridian and Horizon	63	26	06
The height of the Style above the Substyle	03	57	40
The distance of the Substyle from the Meridian	05	28	08
The Planes difference of Longitude	54	11	33

By which means the Substyle will fall between 8 and 6 of the Clock in the East, and 5 and 4 in the West Decliner.

Hours from the Substyle.	Hour-Arches.	Hours from the Substyle.	Hour-Arches.
Substyle.		Substyle.	
½	00 07	08 04	00 24
09 03	00 38	½	00 56
½	01 11	07 05	01 30
10 02	01 47	½	02 08
½	02 27	06 06	02 52
11 01	03 13	½	03 44
½	04 12	05 07	04 51
12 12	05 28	½	06 23
½	07 19	04 08	08 44
01 11	10 18	½	13 58
½	16 17	03 09	23 07
02 10	34 11	½	66 54

The North declining West 58 *d.* 16 *m.* 57 *sec.* adjacent to the Horizontal, doth also decline 54 degrees, and are made by the former Rules. The Particulars are as follow.

The

	d.	m.	sec.
The Plane reclines	30	00	00
Declining East and West	20	54	18
The distance of the Meridian from the Horizon, is	79	11	16
The heighth of the Style above the Substyle	63	28	31
The distance of the Substyle from the Meridian	40	36	56
The Planes difference of Longitude	43	47	06

The Table follows.

Hours from the Substyle.	*H. Arch on the Plane.*	*Hours from the Substyle.*	*H. Arch on the Plane.*
Substyle.		*Substyle.*	
½	05 37	09 03	01 05
10 02	12 23	½	07 49
½	19 13	08 04	14 35
11 01	26 11	½	21 28
½	33 18	07 05	28 29
12 12	40 37	½	35 39
½	48 8	06 06	43 02
01 11	55 53	½	50 38
½	63 51	05 07	58 27
02 10	72 00	½	66 28
½	80 17	04 08	74 40

The North declining West 58 *d.* 16 *m.* 57. *sec.* adjacent to the Horizontal, doth also decline 54 degrees, and are made by the former Rules. The Particulars are as follow.

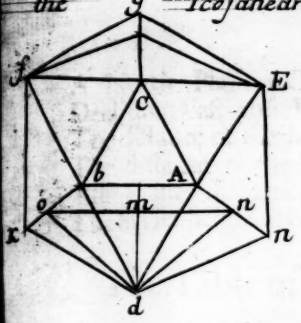
	d.	*m.*	*sec.*
The North Plane reclining	54	00	00
Declining East and West	38	16	57
The distance of the Meridian and Horizon	37	22	39
The height of the Style above the Substyle	55	39	21
The distance of the Substyle from the Meridian	57	40	04
The Planes difference of Longitude	62	24	28

By which means the Substyle will fall between 9 and 10 of the Clock in the East, and 2 and 3 of the Clock in the Afternoon.

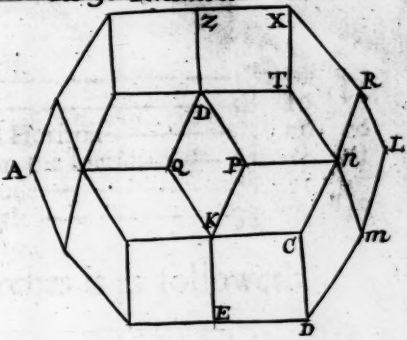
Hours from the Substyle.	*Hour-Arches.*	*Hours from the Substyle.*	*Hour-Arches,*
Substyle.		*Substyle.*	
08 04	01 59	′	05 17
½	08 12	07 05	10 27
09 03	14 31	½	16 48
½	20 59	06 06	23 20
10 02	27 46	½	30 07
½	34 38	05 07	37 12
11 01	41 56	½	44 38
½	49 36	04 08	52 27
12 12	57 49	½	60 36
½	66 06	03 09	69 12
01 11	74 52	½	78 03
½	83 51	02 10	87 05

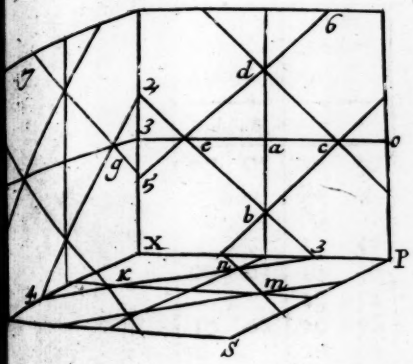
The North declining West 58 *d.* 16 *m.* 57 *sec.* adjacent to the west Rhomb, doth also recline 18 deg. and is to be made as the former Dials were, which did both recline and decline. The Requisites when they are found, will stand thus:

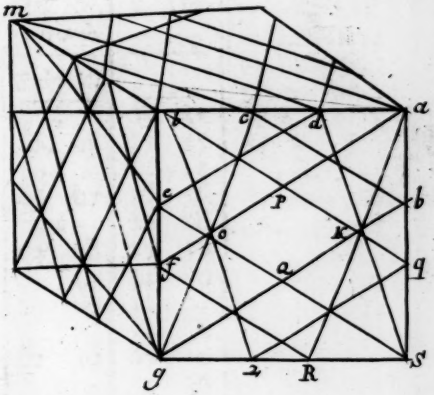
the g Icosahedrum



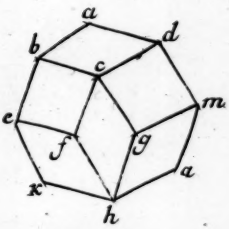
the 30 Rhombes



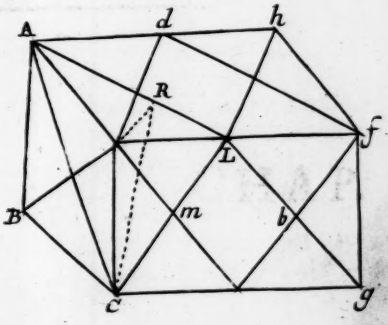


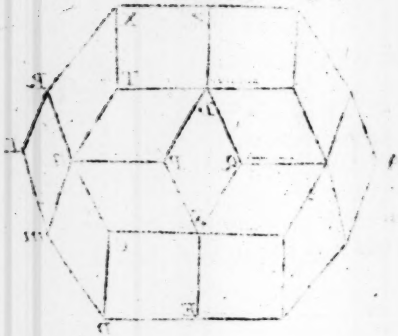


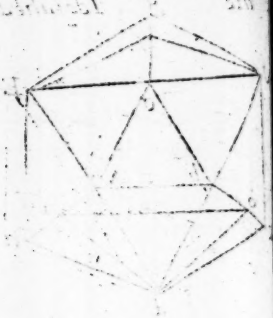


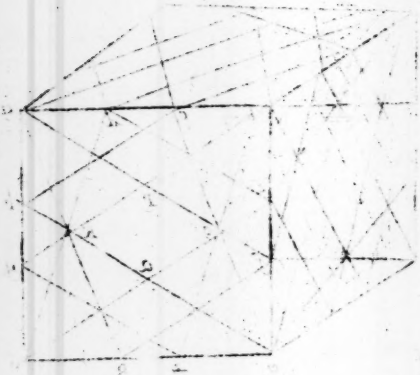


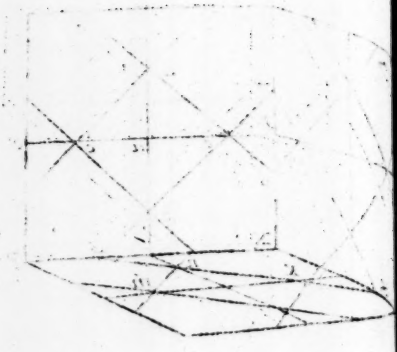
the 12 Rhombes

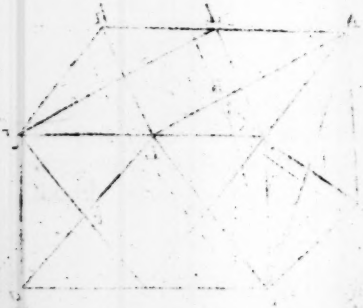












	d.	m.	sec.
A North Plane reclining	18	00	00
Declining East and West	58	16	57
The distance of the Meridian and Horizon	63	26	06
The distance of the Substyle from the Meridian	65	59	31
The Planes difference of Longitude	76	11	40
The Styles height above the Substyle	33	34	18

The Table of Hour-Arches is as followeth.

Hours from the Substyle.	Hour-Arches.	Hours from the Substyle.	Hour-Arches.
Substyle.		Substyle.	
07 05	00 39	1/2	03 31
1/2	04 49	06 06	07 45
08 04	09 06	1/2	12 11
1/2	13 37	05 07	16 56
09 03	18 30	1/2	22 08
1/2	23 52	04 08	27 58
10 02	29 56	1/2	34 39
1/2	36 56	03 09	42 26
11 01	45 08	1/2	51 36
1/2	54 46	02 10	62 20
12 12	66 59	1/2	74 36
1/2	78 29	01 11	87 54

CHAP. XIX.

How the Meridian-Line is to be placed in all thoſe Dyals that are referred to a new Latitude.

THE Meridian Line is not alway to be taken for the Line of 12 at Mid-day (for it often repreſents the midnight) but for that part which helps to deſcribe the Dyal, and doth ſometimes aſcend above the Horizontal Line, and ſometimes deſcends below.

Now in all direct Planes that re- or incline, and in all upright Decliners the Meridian is the ſame with the prime vertical lines in all Eaſt or Weſt re- or incliners it is the ſame with the Horizontal line; in all the reſt the Meridian doth aſcend or deſcend from the Horizontal line. And for the better Underſtanding of its poſition, obſerve the Rules following.

In North reclining Planes, if the declination and reclination be ſuch as to make it become a Polar Dyal, then the Meridian doth deſcend below the horizontal line at that end which is contrary to the Coaſt of Declination.

And if the South Plane inclines and declines ſo as that it becomes a polar Plane, the Meridian doth deſcend alſo from the contrary coaſt of Declination, and the ſix of the Clock hour-line is always the Subſtyle in both.

If the North-plane reclines and declines ſo that it becomes leſs than a polar plane, the Meridian aſcends above the horizontal line the ſame way with the coaſt of declination, and it doth repreſent 12 of the Clock at midnight.

If the Plane be a South Incliner, and the inclination and declination be ſuch, that it becomes leſs than a polar Plane, then the Merid. doth deſcend below the horizontal line the ſame way with the Declination.

If the North reclining Plane reclines and declines ſo that it becomes more than a Polar, the Meridian doth deſcend below the horizontal line, and from that end which lies contrary to the coaſt of the Planes declination.

If the Plane be a South incliner, and inclines and declines ſo much that it becomes more than a polar Plane, the Meridian doth aſcend above the horizontal line contrary to the coaſt of the Planes declination and is only ſerviceable to help to draw the Dyal.

If

If a North Plane inclines and declines ſo much that it makes it leſs than an Equinoctial Plane, the Meridian will aſcend above the horizontal line at that end which lies contrary to the coaſt of the Planes declination.

The South Plane that doth recline and decline ſo much that the Plane becomes leſs than an equinoctial plane, then the Meridian doth deſcend below the horizontal line at that end that lies contrary to the coaſt of declination.

In all North inclining Planes that incline and decline ſo much that the Plane becomes more than an Equinoctial Plane, then the Meridian doth deſcend below the horizontal line at that end thereof that lies next to the coaſt of the Planes declination.

And in all South Recliners and Decliners, if they recline and decline ſo much that it becomes more than an Equinoctial Plane, then the Meridian doth aſcend above the horizontal line at that end which lies the ſame way of the Planes declination.

Now a Plane is ſaid to be a polar Plane when the Reclination and Declination, or the Inclination is ſuch that it lies in the Equinoctial Circle; and it is ſaid to be leſs than a polar Plane when it falls between the Zenith and the Equator, and it is more than a polar Plane when the Plane falls between the Equator and Horizon: and theſe Planes are ſaid to be Equinoctial Planes when the Plane ſhall ſhall ſo recline and decline, or incline and decline that the Plane falls into the Pole, that is, the Plane doth paſs through both Poles, and by that reaſon the Style doth make no angle with the Plane, but doth lie parallel to it, and thoſe Planes are ſaid to be leſs than Equinoctial Planes that paſs between the Pole and the Zenith, and thoſe are ſaid to be more than an Equinoctial Plane when the Plane falls between the Pole and the Horizon.

Note alſo, that in all the Operation for finding of the New Latitude in all South reclining declining Planes, if that Cotangent which comes out be equal to the complement of the Latitude of the Place, then is that Plane an equinoctial Plane; but if it be leſs than the complement of the Latitude, then it is ſaid to be leſs than an equinoctial Plane; but if it exceed the complement of the Latitude, it is ſaid to be more than an equinoctial Plane.

Note alſo, in North reclining declining Planes, if that Cotangent that comes out in finding the new Lat. be equal to the Lat. of the place, then is that a polar Plane: if the lat. of the place exceeds this Arch found, then is it called leſs than a polar Plane; but if this Arch found doth exceed the latitude of the place, then it is called more than a polar Plane. I

have

have been the larger on this Subject, because I would have all those that are Learners not to seek how to place the Meridian-line on all Planes; for on that very thing depends the true drawing of Dyals on all Planes whatsoever.

Now the manner of transferring the Dyal from the Paper-draught upon the Plane, is thus:

First draw a line on the Plane parallel to the Horizon, which may be done by a Level or other convenient Instrument; then make choice of some convenient place in that line for the center of your Dyal; then with a line of Chords or a Semi-circle draw the Meridian on the Plane, making it to ascend or descend according to the former Rules, so much as you find the distance of the Meridian and Horizon to be; then bring your Paper-draught, and placing the Meridian of the Paper-draught to lie on the Meridian of the Plane, you may transfer the Substyle and Hours on the Plane, having respect to the Coast of the Meridians Ascension or Descension (if you have not erred in any of your former workings) then will the Pattern cut out for the Style, being set over the Substyle, have respect to the elevated Pole.

The End of the First Part.

CLAVIS

CLAVIS HOROLOGIÆ.

The Second Part.

CHAP. I.

Of the Furniture with which Sun-Dyals may be Beautified.

MAny are the Astronomical Conclusions that may be described upon every sort of Planes, (*viz.*)

First, The Parallel of the Signs, shewing what part of the Zodiack the Sun is in at all times of the Year.

Secondly, The diurnal Arches shewing the length of the Day and Night throughout the Year.

Thirdly, The time of the Year, shewing by the Shadow of the Sun both the Month and Day.

Fourthly, The Almicanters or Circles of Altitude, shewing the proportions of Shadows, and the height of the Sun above the Horizon at all times of the day.

Fifthly, The Azimuths or vertical Circles, shewing what Points of the Compass the Sun is upon all times of the day.

Sixthly, The *Babyloniſh*, *Italian* and *Jewiſh*, or Planetary hours.

Seventhly,

Seventhly, The Circles of Position, shewing in which of the twelve Celestial Houses the Sun is at all times of the day.

Eighthly, The Sign ascending, descending and culminating.

With many more, some of which are great Circles of the Sphear, others are small: The great Circles in all sorts of plane are represented by straight lines; the smaller are represented by Conick Sections, and those are either Parabola's, Hyperbola's, or Ellipses; only the Signs and diurnal Arches in the Polar, and the Almicanters, or Circles of Altitude in the Horizontal, are perfect Circles.

Such Circles that become straight lines, are all Hour-Circles, Azimuths or vertical Circles, all Circles of position: and that you may the better understand the position of these great Circles on any Plane, consider these few Rules.

First, If the Planes on which such great Circles are described, do lie or stand parallel to those great Circles in the Heavens, then are those straight lines all parallel one to the other: as both an East and West Dyal lying parallel to the Meridian-Circle, all the Hour-Circles are parallel.

But if the Plane should stand perpendicular to any of the corresponding Circles in the Heavens, then the straight lines so projected on the Plane, shall meet in the Center at equal angles.

But if the Plane upon which these great Circles of the Sphere are to be projected, doth lie at oblique angles to the same in the Heavens, then shall all those projected lines representing those Circles in the Heavens meet in one Center upon the Plain, but at unequal Angles.

All smaller Circles of the Sphere (such are all Parallels of the Suns Course or Declination, Almicantors, or Circles of Altitude) being projected on any Plane, become conick Circles, *viz.* either Sections of Ellipses, Paraboles, or Hyperboles, except those smaller Circles be projected upon such Plains as do lie parallel to those smaller Circles in the Heavens, and therefore all Parallels of declination being drawn upon a Plane that doth lie parallel to the equinoctial in the Heavens, which equinoctial is a great Circle of the Sphere; to which these smaller Circles of the Suns course are parallel; those Parallels upon such Planes become perfect Circles.

All Parallels of the Suns Altitude being described on those Planes that do lie parallel to the Horizon, to which great Circle all Circles of Altitude are parallel; those Circles of Altitude being described upon such a Plane, will become perfect Circles.

Note alſo, that all Planes in any Latitude howſoever ſituated in that Latitude, whether they be direct declining, reclining, or do both decline and recline, are in ſome part or other of the world Horizontal Planes, and the height of the Style is equal to the Latitude of that place wherein it is a Horizontal Plane, and the Subſtyle of ſuch a Dyal is the Meridian of that plane, and the difference of Longitude of the ſame Plane ſheweth how much to the Eaſt or Weſt the place doth lie (from the place that the declining reclining Plane doth ſtand) wherein it is a Horizontal Plane.

Therefore when you have made hour and quarter of any declining reclining Plane, or any other Dyal, and if upon the ſame Plane you draw a Horizontal Dyal for the Latitude of that place that is equal to the height of the Style, and let the Subſtyle be the hour-line of 12, and ſo draw all the reſt of the hour-lines from thence, and upon that horizontal Dyal ſo drawn, place all the Furniture; and when you have ſo done, if you expunge all the Horizontal hour-lines, there will remain the Furniture for the Dyal required let it be never ſo irregular, only note that this ſerves for all thoſe Dyals that have Centers: The ſame may be done by drawing the Hour-lines and Parallels of a South-Dyal on the ſame Plane.

Note alſo, As the whole Style or Axis of the Dyal doth ſhew the hour of the day upon the hour-lines, ſo doth the point in the Axis of the Style ſhew the Parallels of the Suns Courſe; that Point repreſenting the Center of the world.

And ſeeing the Furniture of all Dyals that is ſhewed by a Perpendicular ſtyle, depends upon the Altitude of the Sun, therefore have I taken the pains of calculating a Table of Altitude for all Latitudes, from one deg. of Latitude to 90, and Azimuths to each Latitude alſo, and ſhall ſhew the Uſe of them in the placing of the Furniture on all manner of Planes.

A TABLE OF THE Sun's Altitude

At the Entrance of

EACH SIGN,

And for all *HOURS* of the *DAY*.

From one Degree of *Latitude* to 90.

Lat. 1 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♑ ♐	♒
12	67 30	70 47	79 30	89 00	77 30	68 49	65 29
11 01	63 25	63 04	72 06	74 04	70 50	64 24	61 40
10 02	53 32	55 16	58 48	60 00	58 03	54 04	52 12
09 03	40 51	41 56	43 54	45 06	43 24	41 01	39 48
08 04	27 44	27 40	29 33	29 35	29 06	27 35	26 50
07 05	17 49	18 04	18 43	14 37	18 18	17 20	16 52
06 06	00 23	00 23	00 02				

Lat. 2 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♑ ♐	♒
12	68 30	71 47	80 30	88 00	76 30	67 49	64 29
11 01	64 15	64 22	72 31	72 53	70 09	63 33	60 47
10 02	53 58	55 36	58 52	59 56	57 23	53 10	51 19
09 03	41 21	42 26	44 53	44 51	43 14	40 36	39 19
08 04	28 09	28 23	29 45	29 49	28 51	27 11	26 22
07 05	16 22	16 35	16 59	14 36	14 10	13 07	14 29
06 06	00 48	01 03	01 20				

Lat. 3 Deg.

♈	♉	♊ ☋	♋ ♑	♌ ♎	♍ ♓	♏ ♑	♐
12	69 30	72 47	81 29	87 00	75 29	66 47	63 29
11 01	65 05	67 40	73 10	74 42	69 28	62 42	59 55
10 02	54 25	55 56	58 57	59 52	56 43	52 15	50 27
09 03	42 00	42 37	43 58	44 46	43 03	42 11	38 51
08 04	28 35	29 07	29 58	30 04	28 36	26 48	25 54
07 05	14 55	15 17	15 15	14 35	14 03	12 55	12 29
06 06	01 11	01 02	00 36	87 00	87 10	87 10	00 00

Lat. 4 Deg.

♈	♉	♊ ☋	♋ ♑	♌ ♎	♍ ♓	♏ ♑	♐
12	70 30	73 47	82 29	86 00	74 29	65 47	62 29
11 01	65 42	68 11	73 22	74 29	68 38	61 39	58 49
10 02	55 07	56 36	59 22	59 45	56 22	51 52	49 51
09 03	42 21	43 19	44 50	44 52	42 37	39 38	38 14
08 04	29 02	29 28	30 10	29 55	28 21	26 21	25 26
07 05	15 21	15 27	15 29	14 57	13 50	12 35	12 03
06 06	01 36	01 23	00 48	00 00			

Lat. 5 Deg.

♑	♒	♓	♈	♉	♊	♋	♌
12	71 30	74 47	83 30	85 00	73 29	64 47	61 29
11 01	66 37	68 42	73 30	74 12	67 30	60 37	56 47
10 02	57 42	59 16	62 00	59 37	57 38	52 56	50 44
09 03	42 45	43 47	45 04	44 47	42 18	39 09	37 42
08 04	29 25	29 48	30 17	29 52	28 09	25 51	24 47
07 05	15 42	15 47	15 40	14 58	13 36	12 13	11 37
06 06	01 57	01 43	00 58	00 00	00 00	00 00	00 00

Lat. 6 Deg.

♑	♒	♓	♈	♉	♊	♋	♌
12	72 30	75 47	84 29	84 00	72 29	63 47	60 29
11 01	67 16	69 42	74 10	73 52	67 01	59 54	57 03
10 02	56 14	57 37	59 51	59 28	55 25	50 31	48 25
09 03	43 20	44 07	45 12	44 49	43 30	38 34	37 06
08 04	29 51	30 12	30 31	29 49	27 48	25 29	24 29
07 05	16 07	16 08	15 50	14 55	12 22	11 50	11 13
06 06	02 23	02 05	01 12				

Lat. 7 Degl

	♋	♊ ♍	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	73 30	76 47	85 29	83 00	71 29	62 47	59 29
11 01	68 04	70 21	74 33	73 27	66 12	59 02	56 09
10 02	56 48	58 04	60 05	59 02	56 55	59 51	47 42
09 03	43 47	44 29	44 35	44 34	41 32	38 03	36 31
08 04	30 14	30 31	33 42	29 45	27 29	25 03	23 59
07 05	16 30	16 27	16 01	14 53	13 07	11 28	10 46
06 06	2 47	02 25	01 24				

Lat. 8 Deg.

	♋	♊ ♎	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	74 30	77 47	86 29	82 00	70 29	61 47	58 29
11 01	68 50	71 22	74 49	73 02	65 27	57 21	55 13
10 02	57 21	59 21	60 13	59 03	54 21	48 31	46 57
09 03	44 14	44 52	45 32	44 27	41 11	37 38	35 54
08 04	30 38	30 51	30 50	29 41	27 13	24 38	23 29
07 05	16 53	16 46	16 11	14 51	12 55	11 05	10 20
06 06	83 11	02 45	01 35				

Lat. 9 Deg.

	♋	♊ ♎	♉ ♍	♈ ♎	♓ ♏	♑ ♒	♌
12	75 30	78 47	87 30	81 06	69 29	60 47	57 29
11 01	69 37	71 38	75 00	72 34	64 39	57 16	54 20
10 02	57 51	58 56	60 23	58 48	53 37	48 29	46 12
09 03	44 39	45 11	45 41	44 18	40 47	36 59	35 18
08 04	31 01	31 09	30 59	29 36	26 55	24 11	22 58
07 05	17 16	17 06	16 21	14 49	12 40	10 43	10 03
06 06	03 35	03 04	01 47				

Lat. 10 Deg.

	♋	♊ ♎	♉ ♍	♈ ♎	♓ ♏	♑ ♒	♌
12	76 30	79 47	88 30	80 00	68 29	59 47	56 29
11 01	70 23	72 16	75 16	72 02	63 49	56 23	53 22
10 02	58 25	59 21	60 31	58 31	53 13	47 46	45 25
09 03	45 07	45 22	45 14	44 08	40 24	36 20	34 39
08 04	31 25	31 27	31 20	29 32	26 36	23 42	22 25
07 05	17 40	17 27	16 33	14 46	11 05	10 20	09 26
06 06	04 00	02 45	01 36				

Lat. 11 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♑ ♒	♐
12	77 30	80 47	89 30	79 00	67 29	58 47	55 29
11 01	71 01	72 40	75 30	71 29	63 08	54 49	52 30
10 02	58 50	60 13	60 38	58 14	52 33	47 03	44 42
09 03	45 26	45 27	45 58	44 27	40 00	35 30	34 04
08 04	39 49	31 32	31 17	29 19	26 18	23 01	22 01
07 05	18 00	17 35	16 41	14 43	12 10	09 50	09 01
06 06	02 42	03 48	02 11				

Lat. 12 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♑ ♒	♐
12	78 30	81 47	87 30	78 00	66 29	57 47	54 29
11 01	71 42	73 24	75 19	70 53	62 09	54 34	51 33
10 02	59 19	60 15	60 39	57 54	52 02	46 14	43 55
09 03	45 50	46 07	46 00	44 15	39 30	35 18	33 26
08 04	32 06	32 03	31 23	29 17	25 57	22 47	21 25
07 05	18 21	18 11	16 50	14 40	11 55	09 32	08 33
06 06	04 46	04 07	2 23				

Lat. 13 Deg.

	☌	☍ ☊	☌ ☿	☽ ☍	☓ ☊	☐ ♒	♑
12	79 30	82 47	88 29	77 00	65 29	56 47	53 29
11 01	72 19	73 58	75 18	70 15	61 18	53 41	50 38
10 02	59 42	60 24	60 41	57 33	51 27	45 20	43 09
09 03	46 11	46 23	46 03	44 01	39 02	34 39	32 49
08 04	32 26	32 19	31 30	29 09	25 37	22 18	20 55
07 05	18 43	18 19	16 59	14 36	11 39	09 09	08 08
06 06	05 09	04 27	02 35				

Lat. 14 Deg.

♈	☌	☍ ☊	☌ ☿	☽ ☍	☓ ☊	☐ ♒	♑
12	80 30	83 47	87 31	76 00	64 29	55 47	52 29
11 01	72 55	74 25	75 08	69 34	60 28	52 44	49 43
10 02	60 06	60 43	60 35	57 09	50 48	44 50	42 23
09 03	46 30	46 41	46 05	43 32	38 36	34 00	32 11
08 04	32 47	32 37	31 34	29 01	25 17	21 12	20 24
07 05	19 04	18 17	17 07	14 26	11 20	08 44	07 42
06 06	05 32	04 48	02 46				

Lat. 15 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♑ ♐	♑
12	81 30	84 47	86 30	75 00	63 29	54 47	51 29
11 01	73 30	74 47	75 01	68 54	59 36	51 48	48 46
10 02	60 43	60 59	60 37	56 46	50 10	44 04	41 43
09 03	46 51	46 55	46 08	43 33	37 24	33 28	31 32
08 04	33 06	32 52	31 40	28 53	24 56	21 16	19 15
07 05	19 25	18 54	17 17	14 22	10 35	08 20	07 14
06 06	05 56	05 08	02 58				

Lat. 16 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♑ ♐	♑
12	82 30	85 47	85 30	74 00	62 29	53 47	50 29
11 01	74 02	75 09	74 43	68 11	58 44	50 54	47 51
10 02	60 50	61 13	60 33	57 11	49 32	43 17	40 47
09 03	47 09	47 09	46 09	43 17	37 41	32 52	30 52
08 04	33 26	33 06	31 42	28 43	24 33	20 50	19 19
07 05	19 45	19 12	17 02	14 20	10 53	07 53	06 46
06 06	06 19	05 28	03 06				

Lat. 17 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	83 30	86 47	84 30	73 00	61 29	52 47	49 29
11 01	74 29	75 25	74 25	67 28	57 51	44 58	46 54
10 02	61 08	61 25	60 25	55 55	48 42	42 31	39 59
09 03	47 26	47 21	46 04	43 00	37 08	32 14	30 13
08 04	33 34	33 20	31 46	28 34	23 53	20 10	18 46
07 05	20 05	19 26	17 29	14 19	10 36	07 30	06 19
06 06	06 42	05 48	03 19				

Lat. 18 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	84 30	87 47	83 30	72 00	60 29	51 47	48 29
11 01	74 56	75 41	74 07	66 44	56 59	49 03	45 58
10 02	61 27	61 37	60 17	55 27	48 12	41 46	39 11
09 03	47 43	47 32	46 06	42 38	36 36	31 36	29 33
08 04	34 01	33 34	31 50	28 24	23 13	19 50	18 13
07 05	20 26	19 44	17 31	14 14	10 20	07 07	05 53
06 06	07 05	06 08	03 32				

Lat. 19 Deg.

	☌	♊ ☋	♉ ♍	♈ ♎	♓ ♏	♐ ♒	VS
12	85 30	88 47	82 30	71 00	59 29	50 47	47 29
11 01	75 02	75 47	73 37	65 57	56 05	48 07	44 52
10 02	61 35	61 44	60 07	54 59	47 30	40 59	38 11
09 03	47 54	47 42	46 04	42 25	36 07	30 58	32 12
08 04	34 15	33 47	31 52	28 13	23 08	19 20	17 36
07 05	20 28	20 00	17 44	14 10	10 03	06 28	05 24
06 06	07 28	06 27	03 43				

Lat. 20 Deg.

	☌	♊ ☋	♉ ♍	♈ ♎	♓ ♏	♐ ♒	VS
12	86 30	89 47	81 30	70 00	58 29	49 47	46 29
11 01	75 09	75 53	73 25	65 10	55 11	47 11	43 47
10 02	61 44	61 51	59 58	54 28	46 48	40 12	37 11
09 03	48 05	47 52	46 01	42 05	35 39	30 21	31 51
08 04	34 28	38 59	31 55	28 01	23 03	18 50	17 00
07 05	21 01	20 15	17 51	14 04	09 47	06 19	04 46
06 06	07 50	06 47	03 55				

Lat. 21 Deg.

	☌	☍ ☊	☉ ♍	♈ ♎	♐ ♑	♑ ♒	♓
12	87 30	89 47	80 30	69 00	57 29	4847	45 29
11 01	75 37	75 54	72 44	64 23	53 48	46 14	43 04
10 02	62 02	61 56	59 44	53 57	46 08	39 23	36 33
09 03	48 22	48 00	45 55	41 45	34 36	29 42	30 50
08 04	34 46	34 11	31 55	27 49	22 41	18 18	15 57
07 05	21 22	20 31	17 57	13 59	09 30	05 54	04 29
06 06	08 13	07 14	04 06				

Lat. 22 Deg.

	☌	☍ ☊	☉ ♍	♈ ♎	♐ ♑	♑ ♒	♓
12	88 30	88 47	79 30	69 00	56 29	47 47	44 29
11 01	76 05	75 55	72 13	63 34	52 25	45 17	42 12
10 02	62 21	62 01	59 29	53 24	45 24	38 35	35 55
09 03	48 39	48 09	45 56	41 23	33 34	29 05	26 51
08 04	35 04	34 22	31 56	27 37	22 18	17 47	14 55
07 05	21 42	20 47	18 03	13 53	09 14	05 29	04 03
06 06	08 36	07 27	04 17				

Lat. 23 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♒ ♐	♑
12	89 30	87 47	78 30	67 00	53 29	46 47	43 29
11 01	76 08	75 44	71 38	62 46	52 00	44 42	41 16
10 02	62 27	61 57	59 16	52 52	44 41	37 35	35 06
09 03	48 48	48 12	45 35	41 02	33 31	28 24	26 11
08 04	35 16	34 30	31 55	27 25	21 53	16 16	14 54
07 05	21 58	21 00	18 08	13 47	08 56	05 05	03 36
06 06	08 59	07 46	04 28				

Lat. 24 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♒ ♐	♑
12	89 30	86 47	77 30	66 00	54 29	45 47	42 29
11 01	76 11	75 33	71 03	62 06	51 30	43 27	40 20
10 02	62 33	61 54	58 55	52 17	43 58	36 35	34 18
09 03	48 58	48 16	45 20	40 35	33 29	27 45	25 30
08 04	35 29	34 39	31 54	27 11	21 29	16 44	14 53
07 05	22 15	21 14	18 13	13 41	08 39	04 41	03 09
06 06	09 19	08 04	04 39				

Lat. 25 Deg.

♈	♉	♊ ♌	♋ ♍	♐ ♎	♑ ♏	♒ ♐	♓
12	88 30	85 13	76 30	65 00	65 29	44 47	41 29
11 01	76 11	75 18	70 11	61 06	51 06	42 29	39 21
10 02	62 38	61 54	58 34	51 53	43 38	35 58	33 26
09 03	49 06	48 41	48 18	40 16	33 00	27 05	24 47
08 04	35 43	34 48	31 52	26 57	21 04	16 12	14 20
07 05	22 33	21 27	18 18	13 34	08 32	04 15	02 35
06 06	9 43	08 25	04 45				

Lat. 26 Deg.

♈	♉	♊ ♌	♋ ♍	♐ ♎	♑ ♏	♒ ♐	♓
12	87 30	84 13	77 30	64 00	52 29	43 47	40 29
11 01	76 11	75 03	69 19	60 15	50 28	41 42	38 23
10 02	62 43	61 53	58 14	51 06	42 28	35 22	32 35
09 03	49 15	48 25	45 15	39 55	32 22	26 25	24 03
08 04	35 57	34 58	31 51	26 42	20 39	15 40	13 46
07 05	22 51	21 41	18 23	13 27	08 04	03 49	02 01
06 06	10 05	08 43	05 01				

Lat. 27 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♒ ♐	♑
12	86 30	83 13	76 31	63 00	51 29	42 47	39 30
11 01	75 59	74 34	68 48	59 24	49 41	40 42	37 26
10 02	62 42	61 46	57 51	50 30	41 43	34 35	31 45
09 03	49 20	48 22	45 03	39 27	31 47	25 45	23 19
08 04	36 08	35 03	31 43	26 28	20 09	15 10	13 08
07 05	23 07	21 54	18 26	13 20	07 41	03 25	01 53
06 06	10 26	09 01	05 05				

Lat. 28 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♒ ♐	♑
12	85 30	82 13	75 31	62 00	50 29	41 47	38 30
11 01	75 48	74 05	68 18	58 31	48 55	39 43	36 29
10 02	62 41	61 40	57 27	49 52	40 59	33 48	30 55
09 03	49 27	48 20	44 51	39 01	31 13	25 06	22 38
08 04	36 19	35 09	31 35	26 12	19 49	14 40	12 30
07 05	23 23	22 08	18 30	13 13	07 29	03 00	01 46
06 06	10 48	09 20	05 10				

Lat. 29 Deg.

♈	♋	♊ ♎	♉ ♍	♈ ♎	♍ ♓	♒ ♐	♑
12	84 39	81 13	72 31	61 00	43 29	40 48	37 10
11 01	75 39	73 41	67 35	57 39	47 00	38 44	35 02
10 02	62 37	60 29	57 02	49 14	40 24	32 56	30 03
09 03	49 32	48 22	44 39	38 12	30 53	24 24	21 56
08 04	36 29	35 16	31 42	25 55	19 24	14 05	11 57
07 05	23 39	22 20	18 34	13 05	07 10	02 35	00 48
06 06	11 10	09 35	05 33				

Lat. 30 Deg.

♈	♋	♊ ♎	♉ ♍	♈ ♎	♍ ♓	♒ ♐	♑
12	83 30	80 13	71 31	60 00	48 29	39 48	36 30
11 01	75 12	73 17	66 53	56 46	46 03	37 45	34 35
10 02	62 33	60 28	56 37	48 35	39 26	32 04	29 12
09 03	49 37	48 24	44 28	37 46	30 33	23 43	21 15
08 04	36 39	35 24	31 38	25 40	18 56	13 31	11 24
07 05	23 54	22 31	18 38	12 57	06 52	02 09	00 20
06 06	11 31	09 57	05 44				

Lat. 31 Deg.

♈	♋	♊ ♎	♉ ♍	♈ ♎	♓ ♍	♐ ♒	♑
12	82 30	78 13	70 31	59 00	46 29	38 48	35 30
11 01	74 45	72 42	65 05	55 54	45 07	36 48	33 37
10 02	62 24	61 30	56 07	47 55	38 39	31 19	28 22
09 03	49 36	48 18	44 07	37 18	29 38	23 01	20 31
08 04	36 46	35 28	31 31	25 19	19 29	12 58	10 48
07 05	24 07	22 42	18 40	12 49	06 34	01 44	00 10
06 06	11 22	10 15	05 54				

Lat. 32 Deg.

♈	♋	♊ ♎	♉ ♍	♈ ♎	♓ ♌	♐ ♒	♑
12	81 30	78 13	69 31	58 00	46 29	37 48	34 30
11 01	74 18	72 07	65 17	55 00	44 11	35 51	32 39
10 02	62 15	62 32	55 37	47 15	37 52	30 25	27 31
09 03	49 35	48 12	43 47	36 51	28 43	22 18	19 46
08 04	36 54	35 31	31 24	25 05	18 03	12 24	10 13
07 05	24 22	22 53	18 43	12 41	06 16	01 19	
06 06	11 13	10 33	06 04				
05 07	00 37						

Lat. 33 Deg.

♈	♉	♊ ♌	♋ ♍	♎ ♑	♐ ♒	♓
12	89 30	77 13	68 31	57 00	45 29	36 48	33 30
11 01	73 11	71 37	64 28	54 07	43 15	35 12	31 41
10 02	61 47	61 24	55 05	46 35	37 05	29 37	26 39
09 03	49 30	48 08	43 32	36 23	28 09	21 38	19 02
08 04	37 05	35 35	31 17	24 48	17 36	11 52	09 37
07 05	24 49	23 04	18 44	12 31	05 28	00 54	
06 06	12 24	10 51	06 14				
05 07	01 04						

Lat. 34 Deg.

♈	♉	♊ ♌	♋ ♍	♎ ♑	♐ ♒	♓
12	79 39	76 13	57 31	56 00	44 29	35 48	31 30
11 01	72 15	71 08	63 39	53 12	42 19	34 03	30 44
10 02	61 49	60 16	54 34	45 57	36 18	28 49	25 47
09 03	49 35	48 05	43 17	35 53	27 35	20 59	18 19
08 04	37 06	35 40	31 10	24 29	17 09	11 21	09 01
07 05	25 52	23 15	18 45	12 24	05 40	00 29	
06 06	13 55	11 08	06 24				
05 07	01 31						

Lat. 35 Deg.

	♉	♊ ♌	♋ ♍	♈ ♎	♐ ♏	♑ ♒	♓
12	78 30	75 13	66 31	55 00	43 29	34 48	31 30
11 01	72 39	70 18	62 49	52 18	41 37	33 02	29 45
10 02	61 33	59 49	53 33	43 43	35 30	27 55	24 55
09 03	49 29	47 57	43 20	35 28	26 58	20 32	17 52
08 04	37 11	35 40	31 02	24 11	16 40	10 46	07 54
07 05	25 13	23 24	18 47	12 14	05 25	00 14	
06 06	13 15	11 26	06 34				
05 07	02 16						

Lat. 36 Deg.

	♉	♊ ♌	♋ ♍	♈ ♎	♐ ♏	♑ ♒	♓
12	77 30	74 13	65 31	54 00	42 29	33 48	30 30
11 01	72 00	69 26	62 01	51 24	40 26	32 03	28 51
10 02	61 17	59 22	53 30	41 29	34 42	27 03	24 07
09 03	49 24	47 43	42 40	34 54	26 19	19 31	16 53
08 04	37 16	35 38	30 56	23 52	16 10	10 11	07 52
07 05	25 15	23 33	18 48	12 05	05 03		
06 06	13 34	11 42	06 45				
05 07	02 26	00 22					

Lat. 37 Deg.

♈	♋	♊ ♎	♉ ♍	♈ ♎	♐ ♍	♐ ♒	♐
12	70 30	73 13	64 30	53 00	41 30	32 48	29 30
11 01	71 20	68 42	41 09	50 29	39 29	31 05	27 53
10 02	60 58	58 58	52 55	43 46	33 54	26 12	23 14
09 03	49 18	47 32	42 20	34 23	25 41	18 48	16 09
08 04	37 20	35 38	30 45	23 32	15 44	09 37	07 16
07 05	25 27	23 41	18 49	11 56	04 44		
06 06	13 54	11 59	05 54				
05 07	02 53	00 47					

Lat. 38 Deg.

♈	♋	♊ ♎	♉ ♍	♈ ♎	♐ ♍	♐ ♒	♑
12	75 30	72 13	63 30	52 00	40 30	31 48	28 30
11 01	70 39	67 57	60 17	49 35	38 33	30 08	26 56
10 02	60 36	58 32	52 20	43 03	33 06	25 21	22 23
09 03	49 10	47 21	41 59	33 53	25 03	18 05	15 25
08 04	37 22	35 37	30 36	23 13	15 16	09 04	06 41
07 05	25 38	23 50	18 49	11 47	04 26		
06 06	14 12	12 16	07 02				
05 07	03 20	01 13					

Lat. 39 Deg.

	♋		♊ ♌		♉ ♍		♈ ♎		♓ ♍		♐ ♒		♑
12	74	30	71	13	62	31	51	00	39	30	30	48	27	30
11 01	69	57	67	10	59	26	48	40	37	36	29	10	25	58
10 02	60	15	58	05	51	43	42	15	32	17	24	29	21	30
09 03	49	00	47	08	41	35	33	21	24	23	17	22	14	40
08 04	37	24	35	35	30	25	22	52	14	47	08	29	06	03
07 05	25	49	23	57	18	49	11	37	04	07				
06 06	14	32	12	33	07	13								
05 07	03	49	01	38										

Lat. 40 Deg.

	♋		♊ ♌		♉ ♍		♈ ♎		♓ ♍		♐ ♒		♑
12	73	30	70	13	61	30	50	00	38	30	29	48	26	30
11 01	69	11	66	23	58	35	47	44	36	39	28	13	25	00
10 02	59	51	57	37	51	07	41	34	31	28	23	38	20	39
09 03	48	51	46	54	41	13	32	48	23	45	16	39	13	55
08 04	37	51	35	33	30	14	22	34	41	18	07	55	05	27
07 05	26	00	24	04	18	49	11	26	03	45				
06 06	14	51	12	49	07	22								
05 06	04	15	02	02										

Lat. 41 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♑	♐ ♒	♓
12	72 30	69 13	60 31	49 00	37 39	28 48	25 30
11 01	68 28	65 36	57 40	46 48	35 42	27 15	24 03
10 02	59 26	57 09	50 29	40 49	30 38	22 46	19 46
09 03	48 40	46 40	40 56	32 15	23 05	15 56	13 11
08 04	37 26	35 30	30 03	22 10	13 49	07 20	04 51
07 05	26 10	24 12	18 49	11 16	03 28		
06 06	15 10	13 04	07 30				
05 07	04 44	02 29					

Lat. 42 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♑	♐ ♒	♓
12	71 30	68 13	59 31	48 00	36 30	27 48	24 30
11 01	67 39	64 46	56 48	45 52	34 45	26 17	23 04
10 02	58 59	56 37	49 50	40 04	29 49	21 55	18 53
09 03	48 28	46 24	40 24	31 42	22 26	15 12	12 26
08 04	37 25	35 26	29 51	21 49	13 20	06 46	04 15
07 05	26 18	24 18	18 47	11 05	03 10		
06 06	15 29	13 21	07 39				
05 07	05 10	02 53					

Lat. 43 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	70 30	67 13	58 30	47 00	35 30	26 48	23 30
11 01	66 53	63 57	55 55	44 57	33 49	25 21	22 07
10 02	58 30	56 05	49 10	39 18	29 01	21 04	18 02
09 03	48 17	46 07	40 00	31 08	21 47	14 30	11 42
08 04	37 25	35 21	29 38	21 27	12 52	06 13	03 40
07 05	26 28	24 24	18 45	10 55	02 51		
06 06	15 47	13 37	07 48				
05 07	05 38	03 18					

Lat. 44 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	69 30	66 13	57 30	46 00	34 30	25 46	22 30
11 01	66 05	63 07	55 01	44 01	32 51	24 23	21 09
10 02	58 02	55 31	48 30	38 32	28 11	20 12	17 09
09 03	48 01	45 48	39 33	30 34	21 07	13 46	10 57
08 04	37 21	35 15	29 24	23 03	12 21	05 38	03 03
07 05	26 36	24 29	18 44	10 44	02 41		
06 06	16 05	13 51	07 57				
05 07	06 05	03 44					

Lat. 45 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♏	♑ ♒	♓
12	68 30	65 13	56 30	45 00	33 30	24 48	21 30
11 01	65 15	62 16	54 07	43 05	31 54	23 24	20 11
10 02	57 30	54 58	47 49	37 46	27 20	19 20	16 16
09 03	47 46	45 30	39 07	30 00	20 26	13 01	10 12
08 04	37 19	35 10	29 11	20 42	11 51	05 02	02 27
07 05	26 44	24 34	18 41	10 33	02 12		
06 06	16 21	14 08	08 06				
05 07	06 32	04 09					

Lat. 46 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♏	♑ ♒	♓
12	67 30	64 13	55 30	44 00	32 30	23 48	20 30
11 01	64 26	61 24	53 13	42 09	30 56	22 26	19 13
10 02	58 59	54 23	47 08	36 59	26 30	18 37	15 23
09 03	47 30	45 11	38 40	29 25	19 45	12 10	09 27
08 04	27 15	35 03	28 56	20 19	11 22	04 29	01 51
07 05	26 51	24 39	18 39	10 21	01 52		
06 06	16 30	14 22	08 15				
05 07	07 00	04 34					

Lat. 47 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♍ ♓	♒ ♐	♑
12	66 30	63 13	54 30	43 00	31 30	22 48	19 30
11 01	63 36	60 32	52 19	41 12	30 00	21 28	18 15
10 02	56 26	53 47	46 25	36 12	25 39	17 35	14 31
09 03	47 12	49 50	38 11	28 50	19 04	11 33	08 41
08 04	37 11	34 55	28 41	19 56	10 51	03 52	01 14
07 05	26 58	24 43	18 36	10 10	01 34		
06 06	16 58	14 37	08 23				
05 07	07 27	04 59					

Lat. 48 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♍ ♓	♒ ♐	♑
12	65 30	62 13	53 30	42 00	31 30	21 48	18 30
11 01	62 44	59 39	51 24	40 16	29 01	20 30	17 16
10 02	55 51	53 10	45 44	35 25	24 49	16 43	13 38
09 03	46 54	44 28	37 43	28 14	18 23	10 49	07 56
08 04	37 05	34 47	28 26	19 33	10 21	03 18	00 38
07 05	27 04	24 46	18 32	09 58	01 15		
06 06	17 14	14 52	08 31				
05 07	07 54	05 22					

Lat. 49 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	64 30	61 13	52 30	41 00	29 30	20 48	17 30
11 01	61 53	58 47	50 29	39 19	28 04	19 32	16 18
10 02	55 17	52 32	45 00	34 37	23 58	15 50	12 45
09 03	46 35	44 07	37 14	27 38	17 42	10 15	07 11
08 04	36 59	34 38	28 10	19 09	09 51	02 44	00 01
07 05	37 11	24 49	18 29	09 47	00 56		
06 06	17 31	15 06	08 40				
05 07	08 21	05 48					

Lat. 50 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	63 30	60 13	51 30	40 00	28 30	19 48	16 32
11 01	61 02	57 54	49 34	38 23	27 07	18 34	15 20
10 02	54 41	51 53	44 17	33 50	23 08	14 58	11 52
09 03	46 15	43 42	36 44	27 02	17 01	09 20	06 25
08 04	36 54	34 28	27 53	18 45	09 20	02 08	
07 05	27 16	24 52	18 25	09 35	00 36		
06 06	17 48	15 20	08 47				
05 07	08 44	06 12					
04 08	00 37						

Lat. 51 Deg.

	♋	♊ ♎	♉ ♏	♈ ♍	♌ ♑	♐ ♒	♓
12	62 30	59 13	50 30	39 00	27 30	18 48	15 30
11 01	60 09	57 00	48 39	37 26	26 09	17 36	14 22
10 02	54 04	51 14	43 33	33 01	22 17	14 05	10 59
09 03	45 54	43 18	36 14	26 25	16 20	08 36	05 40
08 04	36 40	34 18	27 36	18 20	08 49	01 33	
07 05	27 21	24 54	18 20	09 22	00 17		
06 06	18 04	15 34	08 55				
05 07	09 15	06 37					
04 08	01 14						

Lat. 52 Deg.

	♋	♊ ♎	♉ ♏	♈ ♍	♌ ♑	♐ ♒	♓
12	61 30	58 13	49 30	38 00	26 30	17 48	14 30
11 01	59 16	56 06	47 43	36 29	25 11	16 38	13 24
10 02	53 26	50 34	42 49	32 13	21 26	13 23	10 06
09 03	45 31	42 53	35 43	25 48	15 38	07 51	04 54
08 04	36 38	34 07	27 19	17 56	08 18	00 59	
07 05	27 25	24 56	18 16	09 10			
06 06	18 19	15 47	09 03				
05 07	09 41	07 02	00 03				
04 08	01 50						

Lat. 53 Deg.

		♋		♊ ♌		♉ ♍		♈ ♎		♐ ♓		♑ ♒		♑
12		60	30	57	13	48	30	37	00	25	30	16	48	13	30
11	01	58	23	55	12	46	47	35	33	24	14	15	40	12	26
10	02	52	48	49	53	42	03	31	25	20	35	12	20	09	13
09	03	45	08	42	27	35	11	25	11	14	56	07	07	04	09
08	04	36	29	33	55	27	00	17	31	07	48	00	24		
07	05	27	29	24	57	18	08	08	58						
06	06	18	35	16	00	09	08								
05	07	10	07	07	25	00	22								
04	08	02	27												

Lat. 54 Deg.

		♋		♊ ♌		♉ ♍		♈ ♎		♐ ♓		♑ ♒		♑
12		59	30	56	13	47	30	36	00	24	30	15	48	12	30
11	01	57	29	54	18	45	52	34	36	23	16	14	42	11	27
10	02	52	08	49	12	41	19	30	36	19	44	11	27	08	19
09	03	44	44	42	01	34	39	24	34	14	14	06	22	03	23
08	04	36	19	33	43	26	42	17	05	07	17				
07	05	27	32	24	58	18	05	08	45						
06	06	18	50	16	13	09	17								
05	06	10	33	07	50	00	41								
04	08	03	03	00	01										

Lat. 55 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♓
12	58 30	55 13	46 30	35 00	23 30	14 48	11 30
11 01	56 35	53 23	44 56	33 39	22 18	13 44	10 29
10 02	51 28	48 36	40 33	29 47	18 52	10 35	07 26
09 03	44 19	41 39	34 07	23 56	13 32	05 37	02 38
08 04	36 08	33 30	26 23	16 40	06 45		
07 05	27 35	24 58	17 59	08 32			
06 06	19 04	16 25	09 24				
05 07	10 59	08 15	01 02				
04 08	03 39	00 46					

Lat. 56 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	57 30	54 13	45 30	34 00	22 30	13 48	10 30
11 01	55 40	52 28	44 00	32 42	22 21	12 46	09 31
10 02	50 47	47 47	39 47	28 58	18 01	09 42	06 33
09 03	43 53	41 05	33 33	23 17	12 50	04 53	01 52
08 04	35 57	33 16	26 04	16 14	06 14		
07 05	27 37	24 57	17 53	08 19			
06 06	19 19	16 38	09 31				
05 07	11 23	08 39	01 20				
04 08	04 14	01 21					

Lat. 57 Deg.

	♋	♊ ♎	♉ ♍	♈ ♎	♓ ♑	♒ ♐	♏
12	56 30	53 13	44 30	33 00	21 30	12 48	09 30
11 01	54 46	51 33	43 03	31 44	20 23	11 48	08 33
10 02	50 05	47 04	39 00	28 09	17 09	08 49	05 40
09 03	43 27	40 36	33 00	22 39	12 08	04 08	01 06
08 04	35 45	33 02	25 44	15 48	05 43		
07 05	27 38	24 57	17 47	08 06			
06 06	19 33	16 49	09 38				
05 07	11 51	09 02	01 40				
04 08	04 52	01 56					

Lat. 58 Deg.

	♋	♊ ♎	♉ ♍	♈ ♎	♓ ♑	♒ ♐	♏
12	55 30	52 13	43 30	32 00	20 30	11 48	08 30
11 01	53 52	50 37	42 06	30 47	19 25	10 50	07 34
10 02	49 23	46 20	38 13	27 19	16 18	07 56	04 47
09 03	42 59	40 07	32 26	22 00	11 26	03 23	00 21
08 04	35 32	32 47	25 23	15 22	05 12		
07 05	27 39	24 55	17 40	07 53			
06 06	19 46	17 01	09 44				
05 07	12 16	09 26	01 59				
04 08	05 28	02 31					

Lat. 59 Deg.

	♋	♌ ♑	♉ ♒	♈ ♎	♓ ♍	♐ ♊	♑
12	54 30	51 13	42 30	31 00	19 29	10 50	07 30
11 01	52 57	49 42	41 11	29 50	18 28	09 51	06 36
10 02	48 40	45 36	37 27	26 29	15 26	07 04	03 53
09 03	42 31	39 37	31 51	21 21	10 43	02 38	
08 04	35 19	32 31	25 02	14 55	04 40		
07 05	27 39	24 54	17 33	07 40			
06 06	20 00	17 12	09 51				
05 07	12 41	09 50	02 19				
04 08	06 04	03 06					
03 09	00 27						

Lat. 60 Deg.

♈	♋	♊ ♑	♉ ♒	♈ ♎	♓ ♍	♐ ♊	♑
12	53 30	50 13	41 31	30 00	18 39	09 50	06 30
11 01	52 01	48 46	40 14	28 53	17 30	08 53	05 38
10 02	47 56	44 51	36 39	25 41	14 35	06 11	03 00
09 03	42 02	39 06	31 16	20 42	10 00	01 54	
08 04	35 05	32 14	24 41	14 29	04 09		
07 05	27 39	24 51	17 26	07 26			
06 06	20 12	17 23	09 57				
05 07	13 04	10 13	02 38				
04 08	06 40	03 41					
03 09	01 13						

Lat. 61 Deg.

♈	♉	♊ ♌	♂ ♍	♈ ♎	♐ ♍	♑ ♒	♓
12	52 30	49 13	40 30	29 00	17 36	08 49	05 30
11 01	51 06	47 50	39 13	27 55	16 32	07 55	40 49
10 02	47 11	44 06	35 52	24 48	13 43	05 18	02 07
09 03	41 33	38 34	30 41	20 03	09 18	01 09	
08 04	34 50	31 58	24 20	14 02	03 37		
07 05	27 37	24 49	17 18	07 12			
06 06	20 25	17 34	10 03				
05 07	13 31	10 36	02 57				
04 08	07 16	04 16					
03 09	01 58						

Lat. 62 Deg.

♈	♉	♊ ♌	♂ ♍	♈ ♎	♐ ♍	♑ ♒	♓
12	51 30	48 13	39 30	28 00	16 39	07 49	04 30
11 01	50 10	46 56	38 22	27 00	15 37	07 00	03 41
10 02	46 28	43 21	35 05	24 01	13 01	04 28	01 15
09 03	41 02	38 04	30 06	19 25	08 38	00 27	
08 04	34 34	31 41	23 59	13 37	03 09		
07 05	27 37	24 46	17 11	07 01			
06 06	20 37	17 45	10 09				
05 07	14 00	11 00	03 35				
04 08	07 52	04 51					
03 09	02 44						

Lat. 63 Deg.

♈	♉	♊ ♌	♋ ♍	♈ ♎	♐ ♏	♑ ♒	VS
12	50 30	47 13	38 31	27 00	15 29	05 49	03 30
11 01	49 14	45 55	37 25	26 51	14 35	06 14	02 41
10 02	45 43	42 15	34 16	23 09	12 02	03 48	00 56
09 03	40 32	37 12	29 29	18 44	07 53	00 32	
08 04	34 18	31 05	23 35	13 07	02 40		
07 05	27 40	24 30	17 06	06 45			
06 06	20 49	16 55	10 15				
05 07	14 18	11 03	03 39				
04 08	08 28	04 46					
03 09	03 30						

Lat. 64 Deg.

♈	♉	♊ ♌	♋ ♍	♈ ♎	♐ ♏	♑ ♒	VS
12	49 36	46 13	37 31	26 09	14 29	05 49	02 29
11 01	48 18	45 05	36 28	25 03	13 34	05 28	01 42
10 02	44 58	41 08	33 27	22 19	11 03	03 08	00 37
09 03	40 01	36 21	28 53	18 03	07 09	00 38	
08 04	34 02	30 29	23 12	12 40	02 00		
07 05	27 43	24 14	17 02	06 31			
06 06	21 01	18 06	10 20				
05 07	14 36	11 07	03 45				
04 08	09 04	15 17					
03 09	04 16						

Lat. 65 Deg.

♈		♋		♊	♌	♉	♍	♈	♎	♐	♑	♒	
12		48	30	45	13	37	31	25	00	13	29	04	50	01	30
11	01	47	42	43	48	35	31	24	05	12	38	04	01	00	45
10	02	44	11	40	57	32	39	21	28	10	12	01	59		
09	03	39	27	35	22	28	16	17	23	06	26				
08	04	33	43	30	19	22	48	12	12	01	29				
07	05	27	30	24	22	16	53	06	17						
06	06	21	14	18	15	10	25								
05	07	15	00	11	48	04	01								
04	08	09	42	6	22										
3	9	05	12												
2	10														
1	11														

Lat. 66 Deg.

♈		♋		♊	♌	♉	♍	♈	♎	♐	♑	♒	
12		47	30	44	13	36	31	24	00	12	29	03	50	00	30
11	01	46	26	42	32	34	35	23	08	11	42	02	34		
10	02	43	25	40	26	31	50	20	38	09	22	00	50		
09	03	38	29	35	24	27	40	16	43	05	43				
08	04	33	26	30	09	22	25	11	44	00	58				
07	05	27	36	24	31	16	44	06	03						
06	06	21	22	18	24	10	30								
05	06	15	25	12	30	04	24								
04	08	10	19	07	26										
03	09	06	07	02	54										
02	10	02	23												
01	11	00	10												

Lat. 67 Deg.

♑	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	46 30	43 13	35 31	23 00	12 29	2 50	12
11 01	45 44	41 52	33 38	22 1	10 43	1 49	11 01
10 02	42 38	39 31	31 00	19 47	08 30	00 25	10 02
09 03	38 9	35 2	27 2	16 2	4 52		09 03
08 04	33 06	29 56	22 03	11 16			08 04
07 05	27 32	24 28	16 34	5 56			07 05
06 06	21 34	18 32	10 35				06 06
05 07	15 47	12 49	4 42				05 07
4 8	10 52	07 53					4 8
3 9	6 42	3 31					3 9
2 10	3 16						2 10
11 1	1 00						11 1
12							12

Lat. 68 Deg.

♑	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	45 30	42 13	24 30	22 00	10 29	01 50	12
11 01	45 02	41 13	32 40	21 12	09 45	01 04	11 01
10 02	41 51	38 36	30 11	18 56	07 38		10 02
09 03	37 47	34 39	26 24	15 21	04 02		09 03
08 04	32 47	29 43	21 38	10 48			08 04
07 05	27 27	24 24	16 24	05 42			07 05
06 06	21 46	18 41	10 40				06 06
05 07	16 10	13 09	05 02				05 07
04 08	11 26	08 20	00 51				04 08
03 09	07 17	04 09					03 09
02 10	04 09	00 57					02 10
01 11	01 50						01 11

Lat. 69 Deg.

☉	♋	♌	♍	♎	♏	♐	♑	♒	♓
12	44 30	41 13	33 31	21 00	09 29	00 50			12
11 01	43 50	40 19	31 43	20 15	08 47				11
10 02	41 03	37 50	29 22	18 05	06 49				10
09 03	37 13	34 05	25 48	14 41	03 25				09
08 04	32 26	29 22	21 13	10 19					08
07 05	27 20	24 18	16 13	05 27					07
06 06	21 53	18 49	10 44						06
05 07	16 34	13 31	05 22						05
04 08	12 01	08 58	01 00						04
03 09	08 00	04 52							03
02 10	05 03	01 49							02
01 11	02 58	00 25							01 11
12	02 30								12

Lat. 70 Deg.

☉	♋	♌	♍	♎	♏	♐	♑	♒	♓
12	43 30	40 13	32 31	20 00	08 29				12
11 01	42 39	39 25	30 46	19 17	07 49				11 10
10 02	40 15	37 04	28 33	17 14	05 53				10
09 03	36 39	33 32	25 08	14 00	02 50				09
08 04	32 06	29 01	20 49	09 51					08
07 05	27 14	24 11	16 03	05 12					07
06 06	22 00	18 57	10 49	00 01					06
05 07	16 57	13 52	05 41						05
04 08	12 35	09 27	01 09						04
03 09	08 42	05 35							03
02 10	05 55	02 41							02 10
01 11	04 07	00 50							01 11
12	03 30								12

Lat. 71 Deg.

☉	♋	♌	♍	♎	♏	♐	♑
12	42 30	38 13	31 31	19 02	6 29	0 0	10 11
11 01	41 28	38 27	29 48	18 29	6 52	0 0	10 02
10 02	39 26	36 15	27 43	16 22	3 1	0 0	09 03
09 03	36 07	32 53	24 28	13 19	2 7	0 0	08 04
08 04	31 45	28 38	20 24	9 22	1 47	0 0	07 05
07 05	27 07	24 3	15 51	4 57	1 22	0 0	06 06
06 06	22 8	19 4	10 52	0 0	1 14	0 0	05 07
05 07	17 25	14 23	6 00	0 0	1 07	0 0	04 08
04 08	13 9	10 3	1 41	0 0	1 02	0 0	03 09
03 09	9 30	6 20	0 0	0 0	0 0	0 0	02 10
02 10	6 49	3 33	0 0	0 0	0 0	0 0	01 11
01 11	5 16	1 48	0 0	0 0	0 0	0 0	12
12	4 30	0 0	0 0	0 0	0 0	0 0	

Lat. 72 Deg.

☉	♋	♌	♍	♎	♏	♐	♑
12	41 30	38 13	30 31	18 06	6 29	0 0	10 11
11 01	40 17	37 7	28 56	17 20	6 53	0 0	10 02
10 02	38 39	35 26	26 53	15 35	4 9	0 0	09 03
09 03	25 25	32 15	23 51	12 37	1 24	0 0	08 04
08 04	31 24	28 16	19 58	8 53	0 0	0 0	07 05
07 05	27 00	23 55	15 40	4 41	0 0	0 0	06 06
06 06	22 17	19 11	10 57	0 0	0 0	0 0	05 07
05 07	17 43	14 35	6 18	0 0	0 0	0 0	04 08
04 08	13 44	10 39	2 13	0 0	0 0	0 0	03 09
03 09	10 18	7 6	0 0	0 0	0 0	0 0	02 10
02 10	7 42	4 26	0 0	0 0	0 0	0 0	01 11
01 11	6 25	2 47	0 0	0 0	0 0	0 0	12
12	5 30	0 0	0 0	0 0	0 0	0 0	

Lat. 73 Deg.

	♉	♊ ☊	♋ ♑	♈ ♎	♌ ♏	♐ ♒	♓
12	40 30	37 13	29 31	17 00	05 29		
11 01	39 34	36 32	27 53	16 24	04 55		
10 02	38 00	34 37	26 02	14 40	03 17		
09 03	34 48	31 38	23 10	11 56	01 10		
08 04	31 01	27 52	19 35	08 24			
07 05	26 52	23 47	15 28	04 26			
06 06	22 27	19 22	11 00				
05 07	18 05	14 56	06 39				
04 08	13 58	10 52	02 44				
03 09	11 03	07 50					
02 10	08 34	05 14					
01 11	07 12	03 23					
12	06 30						

Lat. 74 Deg.

	♉	♊ ☊	♋ ♑	♈ ♎	♌ ♏	♐ ♒	VS
12	39 30	36 13	30 31	16 00	04 29		
11 01	38 52	35 35	26 56	15 27	03 57		
10 02	37 22	33 48	25 12	13 48	02 25		
09 03	34 11	31 00	22 30	11 14			
08 04	30 39	27 29	19 15	07 55			
07 05	26 45	23 37	15 16	04 10			
06 06	22 31	19 34	11 04				
05 07	18 27	15 18	06 51				
04 08	14 13	11 42	03 16				
03 09	11 48	08 34					
02 10	09 27	06 12					
01 11	08 00	04 00					
12	07 30						

Lat. 75 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♏ ♑	♐ ♒	VS
12	38 30	35 13	27 31	15 00	03 29		
11 01	37 54	36 37	25 54	14 48	02 56		10 11
10 02	36 22	34 43	24 25	12 57	01 35		
09 03	33 33	31 46	21 50	10 33			
08 04	30 20	28 01	18 43	07 26			
07 05	26 26	23 56	15 04	03 45			
06 06	12 38	19 34	11 07				
05 07	18 48	15 10	07 11				
04 08	15 08	11 24	03 48				
03 09	12 33	07 48					
02 10	10 21	05 38					
01 11	08 58	03 42					
12	08 30						

Lat. 76 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♏ ♑	♐ ♒	VS
12	37 30	34 13	26 31	14 00	02 29		
11 01	36 47	37 40	24 52	13 31	01 55		10 11
10 02	35 22	35 39	23 40	12 06	00 40		
09 03	32 56	32 31	21 10	09 51			
08 04	29 51	28 33	18 11	06 57			
07 05	26 28	24 16	14 52	03 40			
06 06	22 46	19 35	11 10				
05 07	19 10	15 2	7 31				
04 08	15 58	11 5	4 19				
03 09	13 19	7 3	1 29				
02 10	11 15	5 2					
01 11	09 57	4 24					11 10
12	09 30						

Lat. 77 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	36 30	35 13	25 31	13 00	1 29		
11 01	36 00	38 00	23 58	12 15			
10 02	34 33	33 3	22 44	11 14			
09 03	32 18	30 28	20 30	9 9			
08 04	29 28	27 11	17 42	6 28			
07 05	26 18	23 35	14 38	3 25			
06 06	22 52	19 40	11 12				
05 07	19 30	15 50	7 49				
04 08	16 33	12 30	04 50				
03 09	14 3	11 17	02 12				
2 10	12 7	8 24					
1 11	10 54	6 00					
12	10 30	1 13					

Lat. 78 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	35 30	32 13	24 31	12 00	00 29		
11 01	35 4	31 46	23 4	11 35			
10 02	33 44	30 27	21 49	10 23			
09 03	31 40	28 26	19 50	8 28			
08 04	29 4	25 49	17 17	5 58			
07 05	26 9	22 55	14 25	3 9			
06 06	22 58	19 45	11 15				
05 07	19 51	16 39	08 6				
04 08	17 8	13 54	5 21				
03 09	14 48	11 29	2 55				
02 10	13 00	09 45	1 4				
01 11	11 53	8 35	00 49				
12	11 30	8 13					

Lat. 79 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	VS
12	34 30	31 13	23 31	11 00			
11 01	34 5	30 51	22 5	10 37			
10 02	32 53	29 37	20 58	9 31			
09 03	31 00	27 56	19 16	07 46			
08 04	28 37	25 24	16 50	5 28			
07 05	25 57	22 44	14 12	2 54			
06 06	23 1	19 50	11 17				
05 07	20 11	16 58	8 24				
04 08	17 42	14 27	5 52				
03 09	15 52	12 15	3 32				
02 10	13 53	10 37	1 56				
01 11	12 51	9 34	1 20				
12	12 30	9 13	00 30				

Lat. 80 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	VS
12	33 30	30 13	22 31	10 00			
11 01	33 7	29 56	21 7	9 39			
10 02	32 2	28 47	20 7	8 39			
09 03	30 21	27 26	18 42	7 4			
08 04	28 10	24 56	16 22	4 59			
07 05	25 46	22 33	13 59	2 38			
06 06	23 7	19 55	11 20				
05 07	20 31	17 18	8 42				
04 08	18 15	15 00	6 24				
03 09	16 56	13 00	4 9				
02 10	14 46	11 29	2 49				
01 11	13 49	10 33	1 51				
12	13 30	10 13	1 31				

Lat. 81 Deg.

♈	♉	♊ ☊	♋ ♑	♌ ♎	♐ ♏	♐ ♒	♓
12	32 30	29 13	21 31	9 00			
11 01	32 09	28 54	20 10	8 42			
10 02	31 12	27 56	19 15	7 49			
09 03	29 41	24 36	17 55	6 22			
08 04	28 43	24 30	15 53	4 29			
07 05	25 34	22 21	13 45	2 23			
06 06	23 11	19 58	11 22				
05 07	20 50	17 36	09 00				
04 08	18 48	15 33	06 55				
03 09	17 19	13 44	45 09				
2 10	15 38	12 22	03 40				
1 11	14 48	11 31	02 49				
12	14 30	11 13	02 31				

Lat. 82 Deg.

♈	♉	♊ ☊	♋ ♑	♌ ♎	♐ ♏	♐ ♒	♓
12	31 30	28 13	26 31	8 00			
11 01	31 11	27 55	19 14	7 44			
10 02	30 21	27 5	18 24	6 56			
09 03	29 1	25 46	17 6	5 39			
08 04	27 17	24 3	15 25	4 00			
07 05	25 22	22 8	13 31	2 7			
06 06	23 15	20 1	11 24				
05 07	21 10	17 55	9 18				
04 08	19 20	16 6	7 26				
03 09	17 43	14 28	5 49				
02 10	16 31	13 15	4 34				
01 11	15 46	12 29	3 47				
12	15 30	12 13	3 31				

Lat. 83 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♓	♑ ♒	♑
12	30 30	27 13	18 31	07 00			
11 01	30 18	26 57	18 16	06 45			
10 02	29 30	26 13	17 33	06 04			
09 03	28 20	25 04	16 24	04 56			
08 04	26 45	23 35	14 56	03 29			
07 05	25 10	21 55	12 59	01 51			
06 06	23 18	20 03	11 25				
05 07	21 29	18 13	09 35				
04 08	19 52	16 37	07 57				
03 09	18 28	15 10	06 31				
02 10	17 24	14 07	05 25				
01 11	16 44	13 26	04 44				
12	16 30	13 13	04 31				

Lat. 84 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♓	♑ ♒	♑
12	29 30	26 13	17 31	06 00			
11 01	29 18	26 00	17 19	05 48			
10 02	28 39	25 22	16 42	05 04			
09 03	27 39	24 23	15 43	04 15			
08 04	26 23	23 7	14 27	03 00			
07 05	24 58	21 42	12 27	01 35			
06 06	23 22	20 6	11 27				
05 07	21 48	18 31	09 52				
04 08	20 25	17 19	08 28				
03 09	19 13	15 52	07 15				
02 10	18 17	14 59	06 18				
01 11	17 42	14 25	05 42				
12	17 30	14 13	05 31				

Lat. 85 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♒ ♐	♑
12	28 30	25 13	16 31	5 00			
11 01	28 19	25 2	16 21	4 50			
10 02	27 48	24 31	15 50	4 20			
09 03	26 58	23 44	15 1	3 32			
08 04	25 55	22 38	13 58	2 30			
07 05	24 43	21 28	12 30	1 19			
06 06	23 24	20 8	11 28				
05 07	22 5	18 49	10 9				
04 08	20 56	17 40	9 00				
03 09	19 55	16 37	7 58				
02 10	19 9	15 51	7 10				
01 11	18 40	15 23	6 41				
12	18 30	15 13	6 31				

Lat. 86 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♒ ♐	♑
12	27 30	24 13	15 31	04 09			
11 01	27 21	24 4	15 23	03 52			
10 02	26 56	23 40	14 59	3 38			
09 03	26 18	23 01	14 20	2 50			
08 04	25 27	22 10	13 30	02 00			
07 05	24 29	21 14	12 33	1 4			
06 06	23 26	20 10	11 29				
05 07	22 23	19 07	10 27				
04 08	21 27	18 11	09 30				
03 09	20 38	17 22	8 41				
02 10	20 1	16 44	8 3				
01 11	19 38	16 21	7 40				
12	19 30	16 13	7 31				

Lat. 87 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♑	♓
12	26 30	23 13	14 31	03 00		
11 01	26 23	23 11	14 25	02 54		
10 02	26 04	22 48	14 06	02 36		
09 03	25 36	22 19	13 38	02 07		
08 04	24 48	21 40	13 00	01 30		
07 05	24 15	20 58	12 18	00 40		
06 06	23 28	20 11	11 30			
05 07	22 42	19 24	10 43			
04 08	21 58	18 48	10 00			
03 09	21 21	18 30	09 23			
02 10	20 53	17 55	08 53			
01 11	20 36	17 19	08 35			
12	20 30	17 13	08 31			

Lat. 88 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♑	♓
12	25 30	22 13	13 31	02 00		
11 01	25 26	22 19	13 27	01 56		
10 02	25 13	21 56	13 14	01 44		
09 03	24 55	21 37	12 56	01 25		
08 04	24 09	21 11	12 30	01 00		
07 05	24 02	20 43	12 02	00 31		
06 06	23 29	10 12	11 30			
05 07	22 56	19 40	10 59			
04 08	22 29	19 33	10 31			
03 09	22 04	18 48	10 06			
02 10	21 46	18 29	09 47			
01 11	21 34	18 16	09 35			
12	21 30	18 13	09 31			

Lat. 89 Deg.

	♋	♊ ☽	♉ ♍	♈ ♎	♐ ♏	♒ ♑	♓
12	24 30	21 13	12 31	1 00			
11 01	24 28	21 16	12 29	0 57			
10 02	24 21	21 04	12 23	0 52			
09 03	24 12	20 55	12 13	0 42			
08 04	23 50	20 42	12 00	0 30			
07 05	23 16	20 28	11 46	0 16			
06 06	23 29	20 13	11 30				
05 07	23 13	19 57	11 15				
04 08	23 00	19 43	11 01				
03 09	22 47	19 39	10 48				
02 10	22 38	19 20	10 39				
01 11	22 32	19 14	10 33				
12	22 30	19 13	10 31				

Lat. 90 Deg.

	♋	♊ ☽	♉ ♍	♈ ♎	♐ ♏	♒ ♑	♓
12	23 30	20 13	11 34				
11 01	23 30	20 13	11 31				
10 02	23 30	20 13	11 31				
09 03	23 30	20 13	11 31				
08 04	23 30	20 13	11 31				
07 05	23 30	20 13	11 31				
06 06	23 30	20 13	11 31				
05 07	23 30	20 13	11 31				
04 08	23 30	20 13	11 31				
03 09	23 30	20 13	11 31				
02 10	23 30	20 13	11 31				
01 11	23 30	20 13	11 31				
12	23 30	20 13	11 31				

A

TABLE

OF

Right and Contrary Shadows,

TO EVERY

DEGREE and Tenth MINUTE

OF THE

QUADRANT.

Suns Alt.	0 S p m	1 S p m	2 S p m	3 S p m	4 S p m	Suns Alt.
00	41378, 54	687, 34	343, 44	229, 00	171, 37	60
10	4137, 53	589, 16	317, 14	216, 54	164, 44	50
20	2065, 23	515, 46	294, 31	206, 03	158, 23	40
30	1376, 6	458, 22	274, 54	196, 13	152, 29	30
40	1031, 45	412, 29	257, 40	187, 16	147, 01	20
50	825, 13	374, 55	242, 28	179, 06	141, 56	10
60	687, 34	343, 54	229, 00	171, 37	137, 10	00

Horizontal Shadow. Vertical Shadow.

Suns Alt.	5 S p m	6 S p m	7 S p m	8 S p m	9 S p m	Suns Alt.
00	137, 10	114, 11	97, 44	85, 23	75, 46	60
10	132, 43	111, 04	95, 26	83, 37	74, 32	50
20	128, 33	108, 07	93, 15	81, 55	73, 01	40
30	124, 38	105, 19	91, 09	80, 18	71, 43	30
40	120, 56	102, 40	89, 09	78, 44	70, 27	20
50	117, 28	100, 08	87, 14	77, 13	69, 14	10
60	114, 11	97, 44	85, 23	75, 46	68, 03	00

Horizontal Shadow. Vertical Shadow.

Suns Alt.	10 S p m	11 S p m	12 S p m	13 S p m	14 S p m	Suns Alt.
00	68, 03	61 44	56 27	51 59	48 08	60
10	66, 55	60 47	55 40	51 18	47 32	50
20	65, 49	59 95 52	54 53	50 38	46 58	40
30	64, 45	58 85 59	54 08	49 59	46 24	30
40	63, 43	56 85 07	53 24	49 21	45 51	20
50	62, 43	57 16	52 41	48 44	45 19	10
60	61, 44	56 27	51 59	48 08	44 47	00

Horizontal Shadow. Vertical Shadow.

Suns Alt.	15 S p m	16 S p m	17 S p m	18 S p m	19 S p m	Suns Alt.
00	44 47	41 51	39 15	36 57	34 51	60
10	44 16	41 24	38 51	36 34	34 31	50
20	44 45	40 57	38 27	36 13	34 12	40
30	43 16	40 31	38 04	35 52	33 53	30
40	42 47	40 05	37 41	35 31	33 35	20
50	42 19	39 40	37 18	35 11	33 11	10
60	41 51	39 15	36 56	34 51	32 58	00

Horizontal Shadow. Vertical Shadow.

Suns Alt.	20 S p m	21 S p m	22 S p m	23 S p m	24 S p m	Suns Alt.
00	32 58	31 16	29 42	28 16	26 57	60
10	32 40	31 00	29 27	28 03	26 45	50
20	32 23	30 44	29 13	27 49	26 32	40
30	32 06	30 28	28 58	27 36	26 20	30
40	31 49	30 12	28 44	27 23	26 08	20
50	31 32	29 57	28 30	27 10	25 56	10
60	31 16	29 42	28 16	26 57	25 44	00

Horizontal Shadow. Vertical Shadow.

Suns Alt.	25 S p m	26 S p m	27 S p m	28 S p m	29 S p m	Suns Alt.
00	25 44	24 36	23 33	22 34	21 39	60
10	25 52	24 25	23 23	22 25	21 30	50
20	25 21	24 15	23 13	22 15	21 21	40
30	25 10	24 04	23 03	22 06	21 13	30
40	24 58	23 54	22 53	21 57	21 04	20
50	24 47	23 43	22 44	21 48	20 56	10
60	24 36	23 33	22 34	21 39	20 47	00

Horizontal Shadow. Vertical Shadow.

Suns Alt.	30 S p m	31 S p m	32 S p m	33 S p m	34 S p m	Suns Alt.
00	20, 47	19 58	19 12	18 29	17 47	60
10	10, 39	19 50	19 05	18 21	17 41	50
20	20, 31	19 43	18 57	18 15	17 34	40
30	20, 22	19 35	18 50	18 08	17 28	30
40	20, 14	19 27	18 43	18 01	17 21	20
50	20, 06	19 20	18 36	17 54	17 15	10
60	19, 58	19 12	18 29	17 47	17 08	00

Horizontal Shadow. Vertical Shadow.

Suns Alt.	35 S p m	36 S p m	37 S p m	38 S p m	39 S p m	Suns Alt.
00	17 08	16 31	15 55	15 22	14 49	60
10	17 02	16 25	15 50	15 16	14 44	50
20	16 56	16 19	15 44	15 11	14 39	40
30	16 49	16 13	15 38	15 05	14 33	30
40	16 43	16 07	15 33	15 00	14 28	20
50	16 37	16 01	15 27	14 54	14 23	10
60	16 31	15 55	15 22	14 49	14 18	00

Horizontal Shadow. Vertical Shadow.

Suns

Suns Alt.	40 S p m	41 S p m	42 S p m	43 S p m	44 S p m	Suns Alt.
00	14 18	13 48	13 20	12 52	12 26	60
10	14 13	13 43	13 15	12 48	12 21	50
20	14 08	13 39	13 10	12 42	12 17	40
30	14 03	13 34	13 06	12 39	12 13	30
40	13 58	13 29	13 01	12 34	12 08	20
50	13 53	13 24	12 57	12 30	12 04	10
60	13 48	13 20	12 52	12 26	12 00	00

Horizontal Shadow. Vertical Shadow.

Suns Alt.	45 S p m	46 S p m	47 S p m	48 S p m	49 S p m	Suns Alt.
00	12 00	11 35	11 11	10 48	10 26	60
10	11 56	11 31	11 08	10 45	10 22	50
20	11 52	11 27	11 04	10 41	10 19	40
30	11 48	11 23	11 00	10 37	10 15	30
40	11 43	11 19	10 56	10 33	10 11	20
50	11 39	11 15	10 52	10 30	10 08	10
60	11 35	11 11	10 48	10 26	10 04	00

Horizontal Shadow. Vertical Shadow.

Suns

Suns Alt.	50 S p m	51 S p m	52 S p m	53 S p m	54 S p m	Suns Alt.
00	10 04	09 43	09 23	09 03	08 43	60
10	10 01	09 40	09 19	08 59	08 40	50
20	09 57	09 36	09 16	08 56	08 37	40
30	09 54	09 33	09 12	08 53	08 34	30
40	09 50	09 29	09 09	08 50	08 30	20
50	09 47	09 26	09 06	08 46	08 27	10
60	09 43	09 22	09 03	08 43	08 24	00

Horizontal Shadow. — Vertical Shadow.

Suns Alt.	55 S p m	56 S p m	57 S p m	58 S p m	59 S p m	Suns Alt.
00	08 24	08 06	07 48	07 30	07 13	60
10	08 21	08 03	07 45	07 27	07 10	50
20	08 18	08 00	07 42	07 24	07 07	40
30	08 15	07 57	07 39	07 21	07 04	30
40	08 12	07 54	07 36	07 18	07 01	20
50	08 09	07 51	07 33	07 15	06 59	10
60	08 06	07 48	07 30	07 13	06 56	00

Horizontal Shadow. — Vertical Shadow.

Suns Alt.	60 S p m	61 S p m	62 S p m	63 S p m	64 S p m	Suns Alt.
00	6, 56	6, 39	6, 23	6, 07	5, 51	60
10	6, 53	6, 36	6, 20	6, 04	5, 49	50
20	6, 50	6, 34	6, 17	6, 02	5, 46	40
30	6, 47	6, 31	6, 15	5, 59	5, 43	30
40	6, 45	6, 28	6, 12	5, 56	5, 41	20
50	6, 42	6, 26	6, 10	5, 54	5, 38	10
60	6, 39	6, 23	6, 07	5, 51	5, 36	00

Horizontal Shadow. — Vertical Shadow.

Suns Alt.	65 S p m	66 S p m	67 S p m	68 S p m	69 S p m	Suns Alt.
00	5, 36	5, 21	5, 6	4, 51	4, 36	60
10	5, 33	5, 18	5, 3	4, 48	4, 34	50
20	5, 31	5, 16	5, 1	4, 46	4, 32	40
30	5, 28	5, 13	4, 58	4, 44	4, 29	30
40	5, 26	5, 11	4, 56	4, 41	4, 27	20
50	5, 23	5, 08	4, 53	4, 39	4, 24	10
60	5, 21	5, 06	4, 51	4, 36	4, 22	00

Horizontal Shadow. — Vertical Shadow.

Suns Alt.	70 S p m	71 S p m	72 S p m	73 S p m	74 S p m	Suns Alt.
00	4 22	4 8	3 54	3 40	3 26	60
10	4 20	4 6	3 52	3 38	3 24	50
20	4 17	4 3	3 49	3 36	3 22	40
30	4 15	4 1	3 47	3 33	3 20	30
40	4 13	3 59	3 45	3 31	3 17	20
50	4 10	3 56	3 42	3 29	3 15	10
60	4 8	3 54	3 40	3 22	3 13	00

Horizontal Shadow. Vertical Shadow.

Suns Alt.	75 S p m	76 S p m	77 S p m	78 S p m	79 S p m	Suns Alt.
00	3 13	3 00	2 46	2 33	2 20	60
10	3 11	2 56	2 44	2 31	2 18	50
20	3 8	2 55	2 42	2 29	2 16	40
30	3 6	2 53	2 40	2 26	2 13	30
40	3 4	2 51	2 37	2 24	2 11	20
50	3 2	2 48	2 35	2 22	2 9	10
60	3 00	2 46	2 33	2 20	2 7	00

Horizontal Shadow. Vertical Shadow.

Suns Alt.	80	81	82	83	84	Suns Alt.
	S	S	S	S	S	
	p m	p m	p m	p m	p m	
00	02 07	01 54	01 41	01 28	01 16	60
10	02 05	01 52	01 39	01 26	01 14	50
20	02 03	01 50	01 37	01 24	01 11	40
30	02 00	01 48	01 35	01 22	01 09	30
40	01 58	01 45	01 33	01 20	01 07	20
50	01 56	01 43	01 31	01 18	01 05	10
60	01 54	01 41	01 28	01 16	01 03	00

Horizontal Shadow. — Vertical Shadow.

Suns Alt.	85	86	87	88	89	Suns Alt.
	S	S	S	S	S	
	p m	p m	p m	p m	p m	
00	01 03	0 50	0 38	0 25	0 13	60
10	01 01	0 48	0 36	0 23	0 10	50
20	0 50	0 46	0 34	0 21	0 08	40
30	0 57	0 44	0 31	0 19	0 06	30
40	0 55	0 42	0 29	0 17	0 04	20
50	0 32	0 40	0 27	0 15	0 02	10
60	0 50	0 38	0 25	0 13	00 00	00

Horizontal Shadow. — Vertical Shadow.

Here followeth the Table of Arches of the Hour-Lines Distance from the Meridian in all Horizons, from one Degree of Elevation, till the Pole is elevated 30 Degrees, by which is made all direct Mural, whether upright or reclining Dyals.

	1 11		2 10		3 9		4 8		5 7		6 6	
1	0	16	0	35	1	00	1	44	3	43		
2	0	32	1	9	2	00	3	27	7	25		
3	0	48	1	44	3	00	5	11	11	3		
4	1	5	2	19	4	00	6	54	14	36		
5	1	20	2	53	4	59	8	35	18	1		
6	1	36	3	27	5	58	10	16	21	19		
7	1	52	4	1	6	57	11	55	24	27		
8	2	8	4	35	7	54	13	32	27	24		
9	2	24	5	9	8	54	15	9	30	3		
10	2	40	5	44	9	51	16	45	32	57		
11	2	56	6	18	10	48	18	18	35	27		
12	3	11	6	51	11	44	19	48	37	49		
13	3	27	7	24	12	41	21	17	40	1		
14	3	46	7	57	13	36	22	44	42	5		
15	3	59	8	30	14	31	24	9	44	00		
16	4	14	9	2	15	25	25	31	45	49		
17	4	28	9	35	16	17	26	51	47	30		
18	4	44	10	7	17	10	28	9	49	4		
19	4	59	10	39	18	2	29	25	50	31		
20	5	15	11	10	18	53	30	39	51	55		
21	5	29	11	41	19	43	31	50	53	13		
22	5	44	12	13	20	32	32	59	54	26		
23	5	58	12	43	21	20	34	5	55	34		
24	6	13	13	13	22	8	35	10	56	37		
25	6	6	13	43	22	54	36	12	57	37		

The Continuation of the Arches of the Horizontal Planes, from 25 to 50 Degrees of the Elevation of the Pole.

	1 11		2 10		3 9		4 8		5 7		6 6
26	6	42	14	12	23	40	37	13	56	34	
27	6	57	14	41	24	25	38	11	59	27	
28	7	10	15	00	25	09	39	11	60	37	
29	7	24	15	39	25	52	40	2	61	4	
30	7	38	16	6	26	36	40	54	61	49	
31	7	51	16	34	27	15	41	44	62	30	
32	8	5	17	1	27	55	42	32	63	11	
33	8	19	17	27	28	37	43	20	63	49	
34	8	31	17	54	29	13	44	5	64	24	
35	8	44	18	20	29	50	44	49	64	58	
36	8	57	18	45	30	27	45	31	65	30	
37	9	10	19	9	31	2	46	12	66	0	
38	9	22	19	34	31	37	46	50	66	29	
39	9	24	19	58	32	11	47	28	66	56	
40	9	47	20	22	32	44	48	4	67	23	
41	9	58	20	45	33	16	48	39	67	47	
42	10	10	21	7	33	47	49	13	68	10	
43	10	21	21	30	34	18	49	45	68	33	
44	10	32	21	51	34	47	50	16	68	55	
45	10	44	21	45	35	16	50	46	69	15	
46	10	54	22	33	35	53	51	15	69	34	
47	11	6	22	54	36	11	51	43	69	53	
48	11	16	23	14	36	37	52	9	70	11	
49	11	26	23	33	37	2	52	35	70	27	
50	11	36	23	51	37	27	53	00	70	43	

The Continuation of the Arches of the Horizontal Planes from 50 to 75 Degrees of Elevation of the Pole.

	1 11		2 10		3 9		4 8		5 7		6 6	
51	11	46	24	10	37	52	53	24	73	13		
52	11	55	24	57	38	14	53	40	73	24		
53	12	5	24	45	38	37	54	8	73	27		
54	12	14	25	2	38	58	54	30	73	40		
55	12	23	25	19	39	19	54	49	73	53		
56	12	32	25	35	39	39	55	9	74	5		
57	12	40	25	51	39	59	55	28	74	17		
58	12	48	26	5	40	18	55	45	74	28		
59	12	56	26	20	40	36	56	2	74	39		
60	13	4	26	33	40	54	56	19	74	49		
61	13	11	26	48	41	10	56	34	74	58		
62	13	18	27	1	41	26	56	49	75	7		
63	13	25	27	13	41	42	57	3	75	16		
64	13	32	27	26	41	57	57	17	75	24		
65	13	39	27	37	42	11	57	30	75	32		
66	13	45	27	49	42	25	57	42	73	39		
67	13	52	27	59	42	38	57	54	73	46		
68	14	56	28	9	42	50	58	5	73	53		
69	14	3	28	19	43	2	58	16	73	59		
70	14	8	28	29	43	13	58	26	74	5		
71	14	13	28	38	43	24	58	36	74	11		
72	14	18	28	46	43	34	58	44	74	16		
73	14	22	28	55	43	43	58	53	74	21		
74	14	26	29	2	43	52	59	1	74	25		
75	14	30	29	9	44	0	59	8	74	29		

The

The Continuation of the Arches of the Horizontal Planes from 30 to 60 Degrees of Elevation of the Pole.

	1		2		3		4		5		6	
	11		10		9		8		7		6	
76	14	34	29	15	44	8	59	15	74	34		
77	14	38	29	22	44	15	59	21	74	37		
78	14	41	29	27	44	22	59	26	74	41		
79	14	44	29	32	44	28	59	32	74	44		
80	14	47	29	37	44	34	59	37	74	47		
81	14	49	29	42	44	39	59	41	74	49		
82	14	51	29	44	44	43	59	43	74	50		
83	14	53	29	49	44	47	59	49	74	53		
84	14	55	29	52	44	51	59	52	74	55		
85	14	57	29	54	44	53	59	54	74	57		
86	14	58	29	56	44	56	59	57	74	58		
87	14	59	29	58	44	58	59	58	74	59		
88	14	59	29	59	44	59	59	58	74	59		
89	14	59	30		44	59	59	59	75			
90	15		30		45		60		75			

Lat. 1

A TABLE OF THE Suns Azimuth

From the *East* or *West*, for each Hour of the Day, and the Beginning of each Sign, from One Degree to Ninety.

Lat. 1 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♑	♐ ♒	♓
12	90 00	90 00	90 00	90 00	90 00	90 00	90 00
	N			S			
11 01	58 38	57 45	30 15	20 45	40 30	55 55	61 14
10 02	39 28	34 45	19 10	00 10	38 40	37 15	41 30
09 03	30 50	26 40	15 30		16 49	28 42	32 30
08 04	26 10	23 50	11 30		14 19	24 10	27 50
07 05	20 50	18 50	80 00		05 45	18 13	22 00
06 06							

Lat. 2 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♑	♐ ♒	♓
12	90 00	90 00	90 00	90 00	90 00	90 00	90 00
	N			S			
11 01	57 10	54 40	31 30	28 9	42 5	57 06	61 12
10 02	38 15	34 00	18 32		25 10	38 35	44 6
09 03	30 10	26 15	13 8		18 30	29 16	32 5
08 04	26 10	23 40	12 40		14 9	24 7	27 40
07 05	22 00	18 40	9 00		12 7	22 4	24 00
06 06							

Lat. 3 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♑ ♐	♒
12	90 00	90 00	90 00	90 00	90 00	90 0	90 0
	N			S			
11 01	56 00	50 30	29 20	11 00	43 50	58 10	61 45
10 02	38 10	31 10	18 40		27 5	40 5	43 45
09 03	29 5	25 4	16 9		19 30	29 20	33 40
08 04	25 26	22 00	11 30		15 10	25 12	28 10
07 05	23 10	20 00	10 5		12 40	22 5	24 51
06 06	10 00						

Lat. 4 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♑ ♐	♒
12	90 00	90 00	90 00	90 00	90 00	90 00	90 00
		N					
11 01	54 50	49 40	28 04	S	45 45	59 12	62 50
10 02	36 49	31 33	17 20	15 00	27 35	40 40	44 36
09 03	29 10	24 40	13 10	00 30	19 30	30 30	34 20
08 04	25 00	20 40	10 07		15 30	25 10	28 30
07 05	23 00	19 50	09 00		13 10	22 30	25 10
06 06							

Lat. 5 Deg.

	♋	♊ ☋	♂ ♎	♈ ♎	♐ ♍	♐ ♒	♓
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
	N			S			
11 01	53 28	48 10	27 20	18 8	48 15	62 10	64 20
10 02	31 5	23 30	21 10	8 9	23 30	39 40	43 40
09 03	28 10	21 5	11 10	4 6	20 0	30 0	35 0
08 04	24 30	20 50	10 20	1 10	15 00	25 50	29 10
07 05	29 50	19 56	9 0	0 0	12 0	22 10	25 20
06 06	23 50	19 0					

Lat. 6 Deg.

	♋	♊ ☋	♂ ♍	♈ ♎	♐ ♍	♐ ♒	♓
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
	N			S			
11 01	55 49	45 54	21 20	21 0	49 28	61 10	64 10
10 2	34 0	29 5	12 5	10 0	30 6	42 36	46 36
09 03	27 5	22 10	10 7	4 10	17 10	32 15	35 40
08 04	23 50	20 0	10 0	2 5	16 40	26 10	29 10
07 05	30 0	19 10	10 30	1 10	14 10	12 10	15 36
06 06	23 0	20 0					

Lat. 7 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♑ ♏	♐ ♒	♓
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
	N			S			
11 01	50 40	43 40	17 50	25 10	51 10	61 48	64 20
10 02	33 10	27 28	11 20	13 50	26 5	43 10	46 56
09 03	25 20	21 50	12 40	6 6	22 10	32 40	36 20
			S				
08 04	23 10	19 5	12 41	2 10	19 30	26 30	29 30
07 05	22 29	19 0	10 0	1 20	14 10	22 40	25 40
06 06	23 0	20 16					
05 07							

Lat. 8 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♑ ♏	♐ ♒	♓
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
	N			S			
11 01	48 45	40 40	13 0	27 30	52 20	63 18	65 25
10 02	31 50	23 27	9 10	18 49	32 40	45 10	47 40
09 03	25 10	21 10	9 0	7 30	23 8	33 17	36 50
08 04	22 40	19 0	8 7	4 30	17 16	27 6	30 0
			S				
07 05	22 10	19 5	10 10	2 10	14 0	22 50	26 10
06 06	23 30	20 20	11 0				
05 07							

Lat. 9 Deg.

♈	♉	♊	♋	♌	♍	♎	♏	♐	♑
12	90 00	90 00	90 00	90 0	90 0	90 0	90 0	90 0	
	N			S					
11 01	46 50	39 30	11 30	30 10	53 41	63 25	65 55		
10 02	30 10	24 20	7 0	14 50	34 15	43 35	40 15		
09 03	24 30	20 00	6 40	9 30	23 50	34 0	37 30		
			S						
08 04	22 00	18 15	6 50	5 26	17 48	27 15	30 30		
07 05	22 10	18 40	9 50	2 30	14 5	23 0	26 40		
06 06	23 10	20 10	11 30						
05 07									

Lat. 10 Deg.

♈	♉	♊	♋	♌	♍	♎	♏	♐	♑
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0		
	N			S					
11 01	44 56	37 5	3 40	33 10	53 40	63 12	66 30		
10 02	28 40	23 10	5 15	15 0	34 30	45 0	49 15		
09 03	23 20	19 40	6 40	9 0	23 40	34 10	38 0		
			S						
08 04	21 40	17 50	6 30	5 30	17 56	21 10	30 40		
07 05	22 0	18 10	9 10	2 20	14 8	23 10	26 10		
06 06	23 8	20 0	11 6						

Lat. 11 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♑ ♐	♒
12	90 00	90 00	90 00	90 00	90 00	90 00	90 00
	N		S				
H 01	43 15	35 15	1 40	35 20	55 40	65 20	67 5
10 02	27 19	19 10	4 10	18 10	36 10	46 20	49 40
09 03	22 40	19 20	5 0	8 10	25 18	35 20	38 39
08 04	21 10	17 10	6 10	6 0	18 50	28 15	31 40
07 05	21 35	18 10	8 40	2 0	19 10	23 20	26 30
06 06	23 5	19 50	11 0				
5 7							

Lat. 12 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♑ ♐	♒
12	90 00	90 00	90 00	90 00	90 00	90 00	90 00
	N		S				
H 01	40 45	32 0	1 0	37 31	57 19	65 12	67 40
10 02	26 10	19 20	3 50	20 0	37 16	47 10	50 20
09 03	21 40	17 50	4 0	9 30	26 10	35 36	39 10
08 04	20 56	16 50	6 0	6 10	19 0	28 10	31 30
07 05	21 10	17 10	8 0	3 0	19 30	23 50	26 26
06 06	23 10	20 10	10 0				

Lat. 13 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♍	♒ ♐	♑
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
	N			S			
11 01	38 30	28 30	0 0	39 56	58 10	65 45	68 0
			S				
10 02	24 10	21 40	1 0	21 10	38 10	48 10	51 10
09 03	20 30	16 30	3 30	10 50	27 2	36 12	38 15
08 04	20 00	16 10	4 10	8 5	19 30	28 30	31 40
07 05	20 50	17 0	7 5	3 10	14 56	23 30	26 36
06 06	23 0	20 0	10 40				

Lat. 14 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♍	♒ ♐	♑
12	90 00	90 00	90 00	90 00	90 00	90 00	90 00
	N			S			
11 01	36 5	25 10	8 10	42 5	59 5	66 20	68 26
10 02	23 30	17 5	2 30	22 36	39 5	48 32	47 12
			S				
09 03	19 40	14 50	1 10	12 56	30 15	37 0	40 0
08 04	19 10	15 5	3 5	8 0	20 0	29 10	32 20
07 05	20 40	17 5	8 10	4 10	15 10	24 0	26 30
06 06	22 30	19 30	11 0				

Lat. 15 Deg.

♈	♉	♊ ♌	♋ ♍	♎ ♓	♐ ♑	♒	VS
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
11 01	N			S			
	33 30	22 40	11 10	44 0	59 55	66 50	68 55
10 02	20 30	14 30	2 10	24 0	39 40	49 10	52 0
09 03	18 40	14 10	1 20	12 50	29 30	37 25	40 30
08 04			S				
	18 20	14 50	1 10	8 5	20 10	19 10	32 40
07 05	20 10	16 55	6 10	3 0	15 30	23 50	26 50
06 06	22 40	19 10	11 0				

Lat. 16 Deg.

♈	♉	♊ ♌	♋ ♍	♎ ♓	♐ ♑	♒	VS
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
	N			S			
11 01	30 10	18 5	15 30	45 50	62 30	67 24	69 10
10 02	19 30	13 6	3 20	22 35	40 40	49 50	52 40
09 03	18 0	13 0	0 0	14 0	29 0	38 0	41 0
	S		S				
08 04	18 5	13 5	2 10	10 0	21 0	29 35	32 35
07 05	20 0	16 10	7 5	4 40	15 40	24 0	27 0
06 06	22 30	19 0	11 50				

Lat. 17 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♑ ♒	♐
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
	N			S			
11 1	27 20	15 5	19 10	47 30	61 40	69 50	69 40
10 2	18 30	11 30	6 40	26 50	41 50	50 26	53 10
09 03	17 5	12 16	3 5	14 30	29 30	38 20	41 26
			S				
08 04	17 30	13 50	1 40	10 10	21 50	30 0	33 0
07 05	19 30	16 10	6 30	4 10	15 35	23 30	27 0
06 06	22 15	19 15	11 42				

Lat. 18 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♑ ♒	♐
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
	N			S			
11 01	24 0	12 0	22 30	49 8	62 12	68 15	70 0
10 02	17 0	10 0	7 10	28 0	42 30	51 10	53 40
09 03	15 10	10 50	1 30	15 40	30 10	38 50	41 45
			S				
08 04	16 30	12 30	2 50	10 30	22 20	30 30	33 25
07 05	19 10	16 0	7 50	4 16	16 0	24 0	27 0
06 06	22 30	19 0	11 50				

Lat. 19 Deg.

12	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♑ ♐	♒
	90 0	90 0	90 0	90 0	90	90 0	90 0
	N	N	S	S			
11 11	23 40	10 10	26 10	50 36	62 50	68 10	70 25
10 12	14 56	8 40	11 16	29 10	43 26	49 22	53 15
09 03	14 40	8 50	5 0	17 0	31 10	35 50	39 30
			N				
08 04	16 20	11 40	1 30	10 30	22 40	30 36	33 30
07 05	19 10	15 10	0 28	3 10	6 0	24 10	27 10
06 06	22 30	18 49	11 20				

Lat. 20 Deg.

12	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♑ ♐	♒
	90 0	90 0	90 0	90 0	90 0	90 0	90 0
	N	N	S	S			
11 01	23 5	5 0	27 30	51 50	63 38	69 15	72 40
10 02	14 30	5 20	11 50	30 30	44 10	52 6	53 45
09 03	14 10	9 30	4 50	18 0	31 25	39 45	40 15
			N				
08 04	15 30	10 30	1 30	12 10	22 50	31 10	33 44
07 05	18 10	15 10	5 30	5 0	16 30	24 30	27 16
06 06	22 20	19 0	11 30				

Lat. 21 Deg.

♈ ♎	♉ ♏	♊ ♐	♋ ♑	♌ ♒	♍ ♓	♎ ♈	♏ ♉	♐ ♊	♑ ♋	♒ ♌	♓ ♍
12 00	90 00	90 00	90 00	90 00	90 00	90 00	90 00	90 00	90 00	90 00	90 10
	N	N	S	S	N	N					
11 01	17 20	5 0	31 15	52 45	64 35	69 30	71 5				
10 02	12 30	4 30	23 0	31 40	44 50	52 25	55 7				
09 03	14 50	7 5	5 10	18 30	32 35	40 25	40 56				
			N	N							
08 04	13 10	10 10	0 0	12 30	23 15	31 0	34 15				
07 05	18 0	14 55	04 30	08 40	16 30	24 30	27 30				
06 06	22 10	18 50	10 30								

Lat. 22 Degr.

♈ ♎	♉ ♏	♊ ♐	♋ ♑	♌ ♒	♍ ♓	♎ ♈	♏ ♉	♐ ♊	♑ ♋	♒ ♌	♓ ♍
12 00	90 00	90 00	90 00	90 00	90 00	90 00	90 00	90 00	90 00	90 00	90 00
	N	S	S		N	N					
11 01	31 39	84 55	33 40	54 18	64 45	69 50	71 20				
10 02	18 40	N	15 0	32 40	47 35	53 10	55 25				
09 03	11 30	1 10	5 50	20 0	33 40	40 36	43 30				
		5 20	N	N							
08 04	14 10	10 10	0 30	12 30	23 30	31 30	34 45				
07 05	18 5	14 30	5 0	16 40	24 10	27 30					
06 06	22 10	18 40	8 40								
05 07											

Lat. 23 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♑ ♏	♐ ♒	♓
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
	N	S	S	S			
11 1	6 30	8 36	36 30	55 30	60 40	70 10	71 35
		N					
10 2	5 50	1 20	16 55	34 0	46 20	53 40	55 50
09 03	11 10	6 20	7 10	20 30	33 35	41 10	43 35
08 04	13 5	10 0	0 40	13 0	24 0	32 10	34 40
			N				
07 05	17 50	14 10	5 10	6 30	16 40	24 30	27 40
06 06	22 0	18 30	10 30				

Lat. 24 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♑ ♏	♐ ♒	♓
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
	N	S	S				
11 01	3 30	13 0	38 35	56 25	65 50	70 29	71 52
10 02	4 50	6 10	18 0	35 10	46 49	54 10	56 18
		N					
09 03	10 10	7 5	10 30	21 10	33 42	41 35	44 10
08 04	12 50	8 30	0 30	15 0	24 10	31 55	34 45
			N				
07 05	17 0	13 30	5 0	6 50	16 45	24 50	27 40
06 06	22 10	18 30	10 40				

Lat. 25 Deg.

		♋	♊ ♌	♎ ♍	♈ ♑	♓ ♒	♐	♑
12		90 00 S	90 00 S	90 00 S	90 00	90 00	90 0	90 0
11	01	5 30 N	16 20	41 30	57 30	58 16	70 45	72 9
10	02	3 10	5 0 N	20 0	36 9	45 10	54 30	56 40
09	03	7 16	3 10	11 30 N	22 10	34 5	42 9	44 30
08	04	12 10	8 50	1 10	14 10	24 20	32 5	35 10
07	05	16 30	13 10	4 50	7 30	16 40	24 40	27 50
06	06	22 0	18 10	10 30				

Lat. 26 Deg.

		♋	♊ ♌	♎ ♍	♈ ♑	♓ ♒	♐	♑
12		90 00 S	90 00 S	90 00 S	90 00 S	90 00	90 00	90 00
11	01	5 30 N	19 10	44 0	58 80	66 39	76 10	72 22
10	02	1 40	5 10 N	21 25	37 5	48 20	54 45	56 50
09	03	8 30	4 00	10 30	22 50	34 45	42 10	44 45
08	04	11 50	7 10	2 30 N	14 10	24 50	32 30	35 10
07	05	16 10	13 10	4 50	6 50	17 10	24 50	27 50
06	06	21 50	18 10	10 30				

Lat. 27 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♒ ♐	♑
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
	S	S	S	S			
11 01	10 10	24 10	45 40	59 24	66 52	71 20	72 33
10 02	0 30	8 10	22 55	38 10	48 50	55 10	57 20
	N	N					
09 03	7 10	0 10	11 32	23 50	35 25	42 35	45 5
08 04	10 30	7 10	2 20	14 30	25 16	32 40	35 29
			N				
07 05	15 10	13 10	3 55	7 10	17 20	25 0	27 55
06 06	21 30	18 12	10 40				

Lat. 28 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♒ ♐	♑
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
	S	S					
11 01	15 5	27 55	46 35	60 15	67 20	71 35	72 48
10 02	2 40	9 30	24 10	39 0	49 25	55 38	57 40
	N						
09 03	6 10	1 5	12 30	24 50	35 42	42 55	45 30
		N					
08 04	10 0	5 10	3 10	15 10	25 49	33 0	35 36
			N				
07 05	15 5	12 10	3 50	8 00	17 30	25 0	27 55
06 06	21 20	18 5	10 30				

Lat. 29 Deg.

♈	♋	♊ ♄	♉ ♃	♈ ♎	♐ ♑	♐ ♒	♓
12	90 0	90 0	90 0	90 0	0 0	90 0	0
	S	S	S				
11 01	18 30	30 20	48 20	61 3	68 06	71 36	73 5
10 02	3 40	17 30	25 20	39 55	49 50	55 55	57 52
	N	N					
09 03	3 10	4 30	12 45	26 0	36 10	43 10	45 40
			N				
08 04	9 30	4 40	3 55	15 30	25 40	33 10	35 50
07 05	15 0	12 0	3 48	8 30	18 0	25 0	27 59
06 06	11 0	18 0	10 0				

Lat. 30 Deg.

♈	♋	♊ ♄	♉ ♍	♈ ♎	♐ ♏	♐ ♒	♓
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
	S						
11 01	22 0	32 20	49 40	61 44	68 32	72 12	73 15
10 02	6 0	17 40	27 5	40 35	50 30	56 40	58 18
09 03	0 0	4 35	14 0	26 40	36 20	43 35	44 35
	N	N					
08 04	7 10	4 30	4 10	16 10	26 10	33 20	35 55
			N				
07 05	14 30	11 10	2 10	8 40	17 36	25 30	28 0
06 06	20 40	17 30	9 10				

Lat. 31 Deg.

♈	♉	♊ ♌	♋ ♎	♍ ♎	♐ ♏	♑ ♒	VS
12	90 0	90 0	90 0	90 0	90 0	90 0	90 10
	S	S	S	S	S	S	
11 01	25 40	35 10	51 10	62 26	68 52	73 25	73 25
10 02	6 30	10 20	28 20	41 35	51 5	56 42	58 34
	N						
09 03	0 30	5 10	14 10	27 10	37 15	43 51	46 10
		N					
08 04	8 50	5 40	5 10	16 10	25 50	33 29	36 15
			N				
07 05	14 0	11 10	9 50	0 0	17 15	25 10	27 55
06 06	21 0	17 40	9 50				

Lat. 32 Deg.

♈	♉	♊ ♌	♋ ♍	♎ ♎	♐ ♏	♑ ♒	VS
12	90 0	90 0	90 0	90 0	90 0	90 0	90 10
	S	S	S	S	S	S	
11 01	28 50	37 45	52 40	63 22	69 15	74 35	73 39
10 02	10 10	17 50	29 30	42 32	51 38	57 10	58 50
	N	N					
09 03	0 10	5 30	16 0	28 0	37 40	44 10	46 30
08 04	8 10	3 20	5 30	17 10	26 38	33 40	36 28
			N				
07 05	13 16	11 0	1 10	8 10	17 30	25 15	27 05
06 06	20 55	17 30	9 50				
05 07	27 50						

Lat. 33 Deg.

♈	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♏	♒ ♑	♓
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
	S	S	S	S			
11 01	34 45	39 35	53 48	63 45	69 35	72 43	73 47
10 02	13 30	18 30	30 45	43 5	52 10	57 20	59 10
09 03	3 0	6 40	16 45	28 35	38 15	44 34	46 40
	N	N					
08 04	6 30	3 0	6 10	17 29	27 5	34 0	36 30
			N				
07 05	13 0	10 30	0 40	8 30	17 40	25 15	
06 06	20 20	17 15	9 5				
05 07	27 40						

Lat. 34 Deg.

♈	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♏	♒ ♑	♓
12	90 00	90 00	90 00	90 00	90 00	90 00	90 00
	S	S	S	S			
11 01	38 30	41 15	55 5	64 25	70 0	72 50	73 55
10 02	14 0	19 9	32 15	44 45	52 30	57 40	59 25
09 03	4 0	7 10	17 40	29 10	38 35	44 40	47 0
	N	N					
08 04	5 35	1 40	6 4	18 0	27 15	34 5	36 40
			N				
07 05	11 10	9 30	0 10	8 50	17 30	25 10	
06 06	19 10	17 10	8 50				
05 07	27 30						

Lat. 35 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	90 0	90 00	90 00.	90 00	90 0	90 0	90 0
11 01	37 30	43 40	56 10	64 50	70 20	73 10	74 9
10 02	16 10	20 16	34 30	46 10	50 50	57 55	59 40
	S						
09 03	5 10	6 40	16 10	29 30	45 00	44 56	47 10
	N	N	S				
08 04	4 5	0 10	7 24	14 00	27 25	33 15	36 0
			N				
07 05	11 30	9 20	2 17	9 00	18 10	25 10	
06 06	19 30	22 10	7 50				
05 07	27 20						

Lat. 36 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
11 01	39 55	46 17	57 19	65 29	70 32	73 20	74 17
10 02	17 32	22 59	34 34	45 30	53 24	58 11	59 59
	S						
09 03	5 7	9 31	19 35	30 26	39 22	44 54	47 19
	N		S				
08 04	3 50	0 15	8 29	18 44	27 53	34 19	36 41
			N				
07 05	14 14	8 34	0 41	08 57	18 8		
60 06	19 21	16 33	9 20				
05 07	27 31	24 56					

Lat. 37 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	VS
12	90 0	90 00	90 00	90 00	90 0	90 0	90 0
11 01	42 14	48 9	58 18	60 00	70 49	73 31	74 25
10 02	19 51	24 30	35 41	46 11	53 49	58 27	60 3
	S						
09 03	6 17	10 39	20 25	31 2	39 44	45 28	47 31
	N	S					
08 04	2 59	00 15	9 7	19 10	28 9	34 27	36 77
		N					
07 05	11 12	8 7	00 40	9 7	18 13	6 0	
06 06	19 7	16 20	09 13				
05 07	27 29	24 56					

Lat. 38 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	VS
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
11 01	44 20	49 42	59 53	66 29	71 4	73 41	74 33
10 02	20 27	26 1	36 43	46 50	54 12	58 42	60 16
	S						
09 03	7 33	11 39	21 15	31 37	40 6	45 43	47 43
	N	S					
08 04	2 7	1 12	9 40	19 34	28 23	33 36	36 53
		N					
07 05	10 42	7 39	0 40	09 22	18 18		
60 06	18 53	16 9	9 6				
05 07	27 26	24 55					

Lat. 39 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♏ ♓	♒ ♐	♑
12	90 0	90 0	90 0	90 0	90 ●	90 0	90 0
11 01	46 16	51 16	60 6	66 56	71 19	73 51	74 41
10 02	22 35	27 27	37 46	47 28	54 34	58 57	60 28
	S						
09 03	8 45	12 44	22 07	32 11	40 27	45 46	47 54
	N	S					
08 04	1 16	2 3	10 16	19 58	38 37	34 43	36 59
		N	S	9 34	18 22		
07 05	10 13	7 15	0 40				
			N				
06 06	18 38	15 56	08 58				
05 07	27 23	24 54					

Lat. 40 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♏ ♓	♒ ♐	♑
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
11 01	48 5	52 42	60 55	67 22	71 34	74 0	74 49
10 02	24 7	28 51	38 44	48 4	54 56	59 11	60 39
	S						
09 03	9 49	13 58	22 56	32 44	40 47	46 9	48 4
	N	S					
08 04	0 26	2 37	10 51	20 22	28 51	34 50	37 3
		N	S				
07 05	9 46	6 46	0 40	09 46	18 26		
			N				
06 06	18 23	15 43	8 51				
05 07	27 19	24 52					

Lat. 41 Deg.

	♉	♊ ♌	♉ ♍	♈ ♎	♐ ♏	♒ ♐	♑
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
11 01	49 46	54 2	61 41	67 47	71 48	74 8	74 50
10 02	25 43	30 11	39 41	48 39	55 17	59 24	60 50
09 03	10 57	14 46	23 42	33 16	41 7	46 21	48 13
	S						
08 04	0 24	3 19	11 23	20 45	29 4	34 57	37 8
	N		S				
07 05	9 17	6 19	1 3	9 58	18 30		
			N				
06 06	18 8	15 30	8 43				
05 07	27 15	24 00					

Lat. 42 Deg.

	♉	♊ ♌	♉ ♍	♈ ♎	♐ ♏	♒ ♐	♑
12	90 00	90 00	90 00	90 00	90 00	90 00	90 00
11 01	51 20	55 17	62 25	68 11	72 1	74 17	75 3
10 02	27 10	31 30	40 35	49 12	55 36	59 36	61 0
09 03	12 4	15 48	24 30	33 47	41 26	46 32	48 23
	S						
08 04	0 24	4 3	11 57	21 7	29 17	35 3	37 12
	N		S				
07 05	8 49	5 54	1 19	10 10	18 33		
			N				
06 06	17 53	15 16	8 35				
05 07	27 10	24 47					

Lat. 43 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♏	♑ ♒	VS
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
11 01	52 49	56 26	63 6	68 33	72 13	74 24	75 19
10 02	28 37	32 47	41 29	49 45	55 55	59 48	61 10
09 03	13 15	16 49	25 16	34 18	41 44	46 43	48 31
	S						
08 04	1 16	4 49	12 31	21 29	29 29	35 8	37 15
	N		S				
07 05	8 19	5 26	1 45	10 21	18 36		
			N				
06 06	17 37	15 2	8 27				
05 07	27 5	24 44					

Lat. 44 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♏	♑ ♒	VS
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
11 01	54 12	57 31	63 45	68 54	72 25	74 32	75 5
10 02	30 4	34 0	42 20	50 16	56 14	60 0	61 19
09 03	14 13	17 49	26 1	34 47	42 2	46 43	48 38
	S						
08 04	2 27	5 28	13 6	21 51	29 40	35 14	37 18
	N		S				
07 05	7 47	5 1	1 55	10 32	18 13		
			N				
06 06	17 20	14 48	8 19				
05 07	27 0	24 41					

Lat. 45 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♑	♒
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
11 01	55 29	58 33	64 22	69 15	72 37	74 39	75 21
10 02	31 26	35 11	43 10	50 46	56 31	60 10	61 28
09 03	15 16	18 47	26 45	35 16	42 19	47 3	48 46
	S						
08 04	2 59	6 9	13 36	22 13	29 52	35 18	37 20
	N		S				
07 05	7 17	4 34	2 22	10 43	18 41		
			N				
06 06	17 4	14 33	8 11				
05 07	26 54	24 37					

Lat. 46 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♑	♒
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
11 01	56 39	59 31	64 57	69 34	72 48	74 46	75 26
10 02	32 43	36 20	43 57	51 15	56 48	60 21	61 36
09 03	16 18	19 42	27 28	35 44	42 35	47 12	48 53
	S						
08 04	3 50	6 52	14 10	22 34	30 2	35 22	37 22
	N		S				
07 05	6 48	4 4	2 38	10 55	18 43		
			N				
06 06	16 47	14 18	8 2				
05 07	26 47	24 33					

Lat. 47 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♒ ♐	VS
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
11 01	57 45	60 25	65 30	69 53	72 58	74 52	75 31
10 02	33 59	37 26	44 42	51 43	57 4	60 30	61 43
09 03	17 23	23 40	28 10	36 11	42 50	47 21	49 0
	S						
08 04	4 32	7 37	14 42	22 54	30 13	35 26	37 23
	N		S				
07 05	6 18	3 36	2 58	11 5	18 45		
			N				
06 06	16 29	14 4	7 53				
05 07	26 41	24 29					

Lat. 48 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♒ ♐	VS
12	90 00	90 00	90 00	90 00	90 00	90 00	90 00
11 01	58 48	61 17	66. 01	70 10	73 08	74 58	75 36
10 02	35 15	39 30	45 26	52 09	57 19	60 39	61 50
09 03	18 23	21 36	28 52	36 37	43 05	47 29	49 05
	S						
08 04	05 24	08 17	15 13	23 13	30 22	35 29	37 24
	N		S				
07 05	05 49	03 13	03 22	11 16	18 46		
			N				
06 06	16 12	13 48	07 44				
05 07	26 33	24 24					

Lat. 49 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♍ ♑	♐ ♒	VS
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
11 01	59 46	62 4	66 31	70 27	73 18	75 4	75 41
10 02	36 25	39 32	46 8	52 35	57 34	60 48	61 57
09 03	19 25 S	22 29 S	29 31	37 3	43 20	47 35	49 11
08 04	6 9 N	8 58 N	15 44 S	23 33	30 31	35 32	37 24
07 05	5 17	2 47	3 39 N	11 26	18 47		
06 06	15 54	13 33	7 35				
05 07	26 26	24 19					

Lat. 50 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♍ ♑	♐ ♒	VS
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
11 01	60 41	62 48	66 59	70 43	73 26	75 9	75 45
10 02	37 34	40 32	49 49	52 59	57 48	60 56	62 3
09 03	20 23 S	23 23 S	30 19	37 27	43 33	47 43	49 14
08 04	6 48 N	9 40 N	16 15 S	23 51	30 40	35 34	
07 05	4 48	2 16	3 59 N	11 36	18 45		
06 06	15 35	13 17	7 27				
05 07	26 18	24 12					
4 8	37 24						

Lat. 51 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♏ ♑	♐ ♒	VS
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
11 01	61 33	63 31	67 26	70 59	73 35	75 18	75 49
10 02	38 39	41 28	47 29	53 24	58 1	61 3	62 9
09 03	21 20	24 15	30 48	37 51	43 46	47 50	49 19
	S	S					
08 04	07 36	10 18	16 45	24 10	30 49	35 35	
	N	N	S				
07 05	4 15	1 49	4 22	11 46	18 48		
			N				
06 06	15 16	13 0	7 17				
05 07	26 9	24 7					
04 08	37 23						

Lat. 52 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♏ ♑	♐ ♒	VS
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
11 01	62 21	64 11	67 52	71 13	73 43	75 19	75 52
10 02	39 43	42 23	48 6	53 46	58 14	61 10	62 14
09 03	22 19	25 6	31 26	38 15	43 59	47 56	49 23
	S	S					
08 04	8 18	10 58	17 14	24 28	30 56	35 36	
	N	N	S				
07 05	3 46	1 16	4 39	11 55			
			N				
06 06	14 58	12 44	7 7				
05 07	26 0	24 0	18 49				
4 8	37 22						

Lat. 53 Deg.

	♋	♌	♊	♍	♈	♎	♉	♐	♒	♑	♓
12	90 0		90 0		90 0		90 0		90 0		90 10
11 01	63 16		64 49		68 16		71 27		73 51		75 56
10 02	40 43		43 16		45 43		54 8		58 26		62 19
09 03	23 14		25 56		32 13		38 37		44 10		49 26
	S		S								
08 04	9 12		14 39		17 44		24 43		31 3		35 37
	N		N		S				N		
07 05	3 12		0 48		5 12		12 5		1		
06 06	14 38		12 28		6 58						
05 07	25 51		23 53		16 48						
04 08	37 20										

Lat. 54 Deg.

	♋	♌	♊	♍	♈	♎	♉	♐	♒	♑	♓
12	90 0		90 0		90 0		90 0		90 0		90 1 0
11 01	63 45		65 24		68 39		71 40		73 58		75 59
10 02	41 42		44 6		49 17		54 29		58 38		62 23
09 03	24 19		26 44		32 38		38 58		44 12		48 6		49 29
	S		S								
08 04	9 47		12 17		18 13		25 2		31 10		
	N		N		S						
07 05	2 42		0 1		5 20		12 14				
					N						
06 06	14 19		12 10		6 49						
05 07	25 41		23 46		18 47				0		
04 08	37 18		35 37								

Lat. 55 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♑ ♐	VS
12	90 0	90 00	90 00	90 00	90 0	90 0	90 0
11 01	64 49	65 58	69 1	71 53	74 5	75 31	76 2
10 02	43 38	44 55	49 51	54 39	58 48	61 29	62 29
09 03	25 2	27 32	33 12	39 19	44 32	48 10	49 31
	S	S					
08 04	10 32	12 55	18 42	25 19	37 17		
	N	N	S				
07 05	2 3	0 0	5 42	12 23			
		N	N				
06 06	13 59	11 54	6 39				
05 07	25 31	23 38	18 47				
04 08	37 15	35 37					

Lat. 56 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♑ ♐	VS
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
11 01	65 07	66 30	69 22	72 5	74 12	75 38	76 14
10 02	42 32	45 43	50 24	55 19	58 59	61 34	62 30
09 03	25 55	28 19	33 46	39 40	44 42	48 13	49 32
	S						
08 04	11 13	13 34	19 9	25 35	31 23		
	N	S	S				
07 05	1 29	0 48	5 59	12 32			
		N	N				
06 06	13 38	11 36	6 29				
05 07	25 20	23 30	18 46				
04 08	37 12	35 36					

Lat. 57 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	90 0	90 00	90 00	90 00	90 0	90 0	90 0
11 01	65 43	67 1	69 42	72 17	74 18	75 38	76 6
10 02	44 25	46 28	50 55	55 27	59 9	61 39	62 33
09 03	56 45	29 5	34 18	39 59	44 52	48 17	49 33
	S						
08 04	11 55	14 11	19 37	25 50	31 28		
	N	S	S				
07 05	1 8	0 48	6 17	12 40			
		N	N				
06 06	13 17	11 19	6 18				
05 07	25 9	23 21	18 44				
04 08	37 8	35 34					

Lat. 58 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
11 01	66 17	67 29	70 1	72 28	74 24	75 41	78 9
16 02	45 15	47 11	51 25	55 45	59 18	61 43	62 36
09 03	27 36	29 48	34 50	40 18	45 0	48 19	49 34
	S						
08 04	12 38	14 49	20 4	26 5	31 33		
	N	S		S			
07 05	0 29	1 34	6 40	12 48			
		N					
06 06	12 58	11 1	6 9				
05 07	24 57	23 12	18 43				
04 08	37 4	35 32					

Lat. 59 Deg.

♈	♉	♊ ☊	♋ ☋	♌ ♍	♎ ♏	♐ ♑	♒
12	90 00	90 00	90 00	90 0	90 0	90 0	90 0
11 01	66 49	67 57	70 19	72 38	74 29	75 43	76 10
10 02	46 3	47 53	51 54	56 2	59 27	61 46	62 38
09 03	28 25	30 31	35 21	40 36	45 9	48 22	
	S						
08 04	13 18	15 27	20 31	26 20	31 17		
	N	S	S				
07 05	0 29	1 49	6 55	12 56			
		N	N				
06 06	12 35	10 43	5 57				
05 07	24 46	23 3	18 40				
04 08	36 59	35 30					
03 09	49 34						

Lat. 60 Deg.

♈	♉	♊ ☊	♋ ☋	♌ ♍	♎ ♏	♐ ♑	♒
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
11 01	67 26	68 23	70 36	72 48	74 35	75 46	76 12
10 02	46 50	48 34	52 22	56 18	59 35	61 50	62 40
09 03	29 13	31 14	35 51	40 54	45 17	48 23	
08 04	13 59	16 5	20 57	26 34	31 41		
	S	S	S				
07 05	0 29	2 27	7 13	13 4			
	N	N	N				
06 06	12 15	10 25	5 48				
05 07	24 33	22 53	18 38				
04 08	36 54	35 27					
03 09	49 33						

Lat. 61 Deg.

♈	♉	♊ ☊	♋ ☋	♈ ♎	♐ ♓	♑ ♒	VS
0 12	90 00	90 00	90 00	90 0	90 0	90 0	90 10
11 01	67 48	68 47	70 53	72 58	74 39	75 48	76 13
10 02	47 35	49 12	52 48	56 35	59 42	61 53	62 41
09 03	29 58	31 56	36 20	41 10	45 24	48 24	
08 04	14 40	16 39	21 21	26 47	31 45		
	S	S	S				
07 05	1 29	2 47	7 32	13 42			
	N	N	N				
06 06	11 53	10 6	5 37				
05 07	24 20	22 43	18 35				
04 08	36 48	35 24					
03 09	49 32						

Lat. 62 Deg.

♈	♉	♊ ☊	♋ ☋	♈ ♎	♐ ♓	♑ ♒	VS
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
11 01	68 16	69 10	71 8	73 7	74 44	75 50	76 14
10 02	48 17	49 50	53 14	56 49	59 50	61 55	62 42
09 03	30 45	32 34	36 48	41 27	45 30	48 25	
08 04	15 21	17 16	21 47	27 0	31 48		
	S	S	S				
07 05	1 29	3 21	7 51	13 19			
	N	N	N				
06 06	11 31	9 47	5 28				
05 07	24 7	22 23	18 32				
04 08	36 41	35 20					
03 09	49 31						

Lat. 63 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♓	♑ ♒	VS
12	90 00	90 00	90 00	90 00	90 00	90 00	90 00
11 01	68 45	69 36	71 22	73 10	74 48	75 52	76 17
10 02	48 52	50 30	53 28	57 5	59 55	61 57	62 47
09 03	31 40	33 35	37 20	41 45	45 40	48 39	
08 04	16 10	18 50	22 15	27 20	31 50		
	S	S	S				
07 05	1 29	5 40	8 20	13 40			
	N	N	N				
06 06	11 45	10 0	5 30				
05 07	24 40	23 10	18 28				
04 08	36 45	35 30					
03 09	49 40						

Lat. 64 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♓	♑ ♒	VS
12	90 00	90 00	90 00	90 00	90 00	90 00	90 00
11 01	69 15	69 50	71 36	73 25	74 55	75 55	76 29
10 02	49 30	51 30	53 50	57 15	60 5	61 58	62 38
09 03	32 10	34 40	37 36	42 0	45 40	48 39	
08 04	16 30	19 20	22 20	27 36	31 40		
	S	S	S				
07 05	2 0	6 20	8 26	13 20			
	N	N	N				
06 06	11 45	9 50	5 0				
05 07	23 54	23 11	18 10				
04 08	36 45	35 40					
03 09	49 40						

Lat. 65 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	90 00	90 00	90 00	90 00	90 00	90 00	90 00
11 01	69 20	70 22	71 48	73 30	75 57	75 56	76 15
10 02	50 30	51 30	54 20	57 30	60 18	62 0	
09 03	32 30	35 36	38 15	42 10	45 40	61 56	
08 04	17 30	20 0	23 5	27 36	31 40		
	S	S	S				
07 05	5 0	6 30	8 30	13 26			
	N	N	N				
06 06	10 30	9 30	4 50				
05 07	23 30	22 10	18 0				
04 08	36 20	35 2					
03 09	49 20						

Lat. 66 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	90 00	90 00	90 00	90 00	90 00	90 00	90 00
11 01	69 50	70 42	72 0	73 40	75 0	75 58	
10 02	50 40	52 0	54 42	57 45	60 15	62 10	
09 03	34 0	35 38	38 40	43 34	45 49		
08 04	18 0	20 10	23 15	27 56	31 50		
	S	S	S				
07 05	5 0	6 40	8 0	13 30			
	N	N	N				
06 06	10 0	9 10	5 0				
05 07	23 20	21 56	18 15				
04 08	36 10	34 50					
03 09	49 20	48 50					
02 10	62 30						

Lat. 67 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	VS
12	90 0	90 0	90 0	90 0	90 0	90 0	12
	S	S	S				11 01
11 01	70 6	70 54	72 15	73 48	75 4	75 55	
10 02	50 45	52 39	55 10	57 50	60 18	62 20	02
09 03	34 35	36 6	39 5	42 35	46 0		03
08 04	18 50	20 13	23 40	28 0			04
07 05	4 0	5 0	7 40	13 45			05
	N	N	N				
06 06	10 30	9 0	4 50				06
05 07	23 15	21 58	18 10				07
04 08	36 5	34 40					08
03 09	49 15	48 0					09
02 10	62 40						10

Lat. Deg. 68

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	VS
12	90 0	90 0	90 0	90 0	90 0	90 0	12
	S	S	S	S			11 01
11 01	70 21	71 10	72 22	73 50	75 5	75 55	
10 02	52 5	53 0	55 22	58 0	61 20		02
09 03	35 0	36 10	39 24	42 50	46 0		03
08 04	19 0	20 30	24 5	28 10			04
07 05	5 20	5 40	9 10	13 30			05
	N	N	N				
06 06	10 0	7 30	4 40				06
05 07	23 0	21 50	18 10				07
04 08	35 50	34 40	31 40				08
03 09	49 5	48 20					09
02 10	62 34	61 50					10
01 11	76 15						11
12	90 0						12

Lat. 69 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♏	♑ ♒	♓
12	90 0	90 0	90 0	90 0	90 0	90 0	
11 01	S	S	S	S	S		
	70 46	71 22	72 40	74 0	75 8		
10 02	52 25	53 30	55 30	58 10	60 20		
09 03	35 30	36 50	39 40	43 0	46 0		
08 04	20 0	21 0	24 20	28 40			
07 05	5 50	6 0	10 0	14 0			
	N	N	N				
06 06	9 30	7 0	4 0				
05 07	22 30	21 20	17 30				
04 08	35 45	34 30	31 40				
03 09	49 10	48 15					
02 10	62 30	61 45					
01 11	76 20	75 55					
12	90 0						

Lat. 70 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♏	♑ ♒	♓
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
	S	S					
11 01	71 10	72 10	72 50	74 5	75 10		
10 02	53 0	54 0	56 4	58 20	60 22		
09 03	36 0	37 10	40 0	43 10	46 10		
08 04	20 40	21 50	24 40	29 0			
07 05	6 0	6 20	10 20	14 10			
	N	N	N				
06 06	8 10	6 10	3 50				
05 07	22 10	21 5	17 20				
04 08	35 36	34 28	31 36				
03 09	49 10	48 10					
02 10	62 26	61 40					
01 11	76 14	75 50					
12	90 0						

Lat. 71 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	VS
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
	S	S	S	S			
11 01	71 32	72 10	73 5	74 10	75 10		
10 02	53 38	54 23	56 25	58 30	60 35		
09 03	36 50	38 0	40 10	43 20	46 15		
08 04	21 0	22 0	24 50	28 40			
07 05	6 20	7 10	11 0	14 20			
	N	N	N				
06 06	7 50	5 50	3 0				
05 07	22 0	20 30	17 10				
04 08	35 15	34 25	31 30				
03 09	49 0	48 0					
02 10	62 15	61 40					
01 11	76 10	75 50					
12	90 0	90 0					

Lat. 72 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	VS
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
	S	S	S	S			
11 01	71 52	72 12	73 12	74 15	75 12		
10 02	54 0	54 42	56 41	58 40	60 36		
09 03	37 35	38 20	40 50	43 30	46 17		
08 04	21 40	22 50	25 30	28 50			
07 05	6 55	8 10	11 0	14 30			
	N	N	N				
06 06	7 0	5 10	2 50				
05 07	21 40	20 15	17 10				
04 08	35 10	34 15	31 30				
03 09	48 50	48 0					
02 10	62 10	61 40					
01 11	76 9	75 55					
12	90 0	90 0					

Lat. 73 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	VS
12	90 0	90 0	90 0	90 0	90 0		
	S	S	S	S			
11 01	71 5	72 23	73 15	74 20	75 15		
10 02	54 20	55 30	56 50	58 50	60 37		
09 03	37 40	38 50	41 10	43 45	46 20		
08 04	22 40	23 10	25 40	28 55			
07 05	7 20	8 50	11 30	14 35			
	N	N	N				
06 06	6 10	4 50	2 40				
05 07	21 10	20 7	17 5				
04 08	35 0	34 10	31 29				
03 09	48 40	48 0					
02 10	62 22	61 40					
01 11	76 8	75 55					
12	90 0	90 0					

Lat. 74 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	VS
12	90 0	90 0	90 0	90 0	90 0		
	S	S	S	S			
11 01	72 16	72 25	73 30	74 25	75 15		
10 02	54 40	55 30	57 5	59 0	60 39		
09 03	38 30	39 15	41 20	43 50			
08 04	22 35	23 34	25 50	28 55			
07 05	7 50	9 30	11 30	14 30			
	N	N	N				
06 06	7 0	4 40	2 40				
05 07	21 5	20 0	17 10				
04 08	34 35	34 0	31 35				
03 09	48 30	48 0					
02 10	62 12	61 40					
01 11	76 10	75 55					
12	90 0	90 0					

Lat. 75 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	90 00	90 00	90 00	90 0	90 0		
	S	S	S	S			
11 01	72 30	72 30	73 40	74 29	75 20		
10 02	55 15	55 5	57 15	59 10	60 40		
09 03	39 0	38 55	41 45	44 5			
08 04	23 0	23 10	26 10	29 0			
07 05	9 0	8 30	11 30	14 40			
	N	N	N				
06 06	6 10	4 30	2 50				
05 07	21 0	20 10	17 0				
04 08	34 30	34 10	31 45				
03 09	48 20	48 10					
02 10	62 10	61 45					
01 11	76 10	75 55					
12	90 0	90 0					

Lat. 76 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	90 0	90 0	90 0	90 0	90 0		
	S	S	S	S			
11 01	72 45	73 5	73 43	74 35	75 15		
10 02	55 40	54 30	57 40	59 19	60 40		
09 03	39 15	38 5	41 55	44 5			
08 04	24 0	22 6	26 40	29 1			
07 05	9 30	6 30	11 40	14 50			
	N	N	N				
06 06	6 0	4 50	2 50				
05 07	20 30	20 15	17 10				
04 08	34 15	34 6	31 30				
03 09	48 15	48 15	46 5				
02 10	62 5	61 46					
01 11	76 5	75 56					
12	90 0	90 0					

Lat. 77 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♏	♑ ♒	♓
12	90 00	90 00	90 00	90 0	90 0	90 0	90 0
	S	S	S	S			
11 01	72 55	73 12	73 52	74 40			
10 02	56 1	55 55	57 50	59 25			
09 03	40 0	39 45	42 18	44 20			
08 04	24 5	24 0	27 0	29 10			
07 05	9 50	8 0	12 0	14 50			
	N	N	N				
06 06	5 0	5 0	2 50				
05 07	20 10	19 40	17 0				
04 08	34 5	33 35	31 25				
03 09	48 6	47 30	46 0				
02 10	62 5	61 40					
01 11	76 5	75 54					
12	90 0	90 0					

Lat. 78 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♏	♑ ♒	♓
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
	S	S	S	S			
11 01	73 10	73 25	76 6	74 40			
10 02	56 30	57 4	58 10	59 25			
09 03	40 20	41 0	42 35	44 26			
08 04	25 0	25 50	27 10	29 5			
07 05	10 0	11 0	12 30	14 30			
	N	N	N				
06 06	5 0	4 50	2 0				
05 07	19 50	19 10	16 40				
04 08	34 0	33 5	31 15				
03 09	48 0	47 30	46 0				
02 10	61 50	61 35	60 35				
01 11	75 59	75 45	75 18				
12	90 0	90 0					

Lat. 79 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	90 0	90 00	90 00	90 00	90 0	90 0	90 0
	S	S	S	S			
11 01	73 18	73 35	74 13	74 45			
10 02	56 50	57 20	58 20	59 36			
09 03	40 45	41 30	42 40	44 30			
08 04	25 20	26 0	27 30	29 15			
07 05	11 0	11 30	12 30	14 40			
	N	N	N				
06 06	5 10	3 56	01 56				
05 07	19 20	18 50	16 30				
04 08	33 30	33 0	31 5				
03 09	47 40	47 20	46 0				
02 10	61 47	61 30	60 30				
01 11	75 55	75 45	75 15				
12	90 0	90 0	90 0				

Lat. 80 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	90 0	90 0	90 0	90 0	90 0	90 0	90 0
	S	S	S				
11 01	73 33	73 40	74 12	74 48			
10 02	57 20	57 40	58 30	59 39			
09 03	41 20	41 36	42 50	44 31			
08 04	25 30	26 20	27 40	29 30			
07 05	11 30	11 30	12 40	14 30			
	N	N	N				
06 06	4 40	3 45	1 45				
05 07	19 10	18 10	16 30				
04 08	33 20	32 30	31 0				
03 09	47 20	47 5	46 0				
02 10	61 40	61 20	60 29				
01 11	75 52	75 40	75 15				
12	90 0	90 0	90 0				

Lat. 81 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♑ ♐	♑
12	90 0	90 00	90 00	90 00	00	00	12
	S	S	S	S	S	S	
11 01	73 35	73 44	74 15	74 50	73 37	73 18	11 01
10 02	57 35	58 0	58 40	59 40			10 02
09 03	41 30	43 0	43 15	44 35			09 03
08 04	25 31	26 50	28 0	29 40			08 04
07 05	11 35	12 33	13 5	14 31			07 05
	N	N	N				
06 06	3 50	3 40	1 40				06 06
05 07	19 0	18 5	16 25				05 07
04 08	33 0	32 15	30 56				04 08
03 09	47 15	47 0	45 58				03 09
02 10	61 30	61 18	60 28				02 10
01 11	75 48	75 38	75 12				01 11
12	90 0	90 0	90 0				12

Lat. 82 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♑ ♐	♑
12	90 0	90 0	90 0	90 0			12
	S	S	S				
11 01	73 30	74 4	74 20	74 51			11 01
10 02	57 55	58 10	58 50	59 42			10 02
09 03	42 15	42 35	43 32	44 37			09 03
08 04	26 50	27 5	28 10	29 42			08 04
07 05	12 10	12 40	13 30	14 35			07 05
	N	N	N				
06 06	3 0	2 50	1 20				06 06
05 07	18 10	17 30	16 20				05 07
04 08	32 35	32 10	30 45				04 08
03 09	47 5	46 45	45 40				03 09
02 10	61 35	61 12	60 20				02 10
01 11	75 46	75 34	75 11				01 11
12	90 0	90 0	90 0				12

Lat. 83 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♏ ♓	♒ ♐	♑
12	90 0	90 0	90 0	90 0			
	S	S	S	S			
11 01	74 3	74 12	74 30	74 52			
10 02	58 10	58 20	59 5	59 43			
09 03	42 31	42 45	43 45	44 38			
08 04	27 20	27 30	28 20	29 44			
07 05	12 28	13 0	13 35	14 37			
	N	N	N				
06 06	2 50	2 35	1 14				
05 07	18 0	17 20	16 18				
04 08	32 22	32 0	30 40				
03 09	46 50	46 30	45 35				
02 07	61 20	61 2	60 19				
01 11	75 40	75 30	75 10				
12	90 0	90 0	90 0				

Lat. 84 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♏ ♓	♒ ♐	♑
12	90 0	90 0	90 0	90 0			
	S	S	S				
11 01	74 16	74 20	74 32	74 53			
10 02	58 30	58 40	59 10	59 45			
09 03	43 0	43 10	43 50	44 45			
08 04	27 30	28 30	28 40	29 48			
07 05	12 34	13 10	14 5	14 40			
	N	N	N				
06 06	2 5	2 10	1 5				
05 07	18 0	17 5	16 12				
04 08	32 0	31 30	30 35				
03 09	46 30	46 25	45 30				
02 10	61 10	60 50	60 15				
01 11	75 40	75 30	75 9				
12	90 0	90 0	90 0				

Lat. 85 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	90 0	90 0	90 0	90 0			
	S	S	S				
11 01	74 27	74 28	74 36	74 54			
10 02	58 50	59 0	59 12	59 47			
09 03	43 32	43 35	44 0	44 49			
08 04	27 45	28 40	29 0	29 50			
07 05	12 45	13 30	14 25	14 42			
	N	N	N				
06 06	1 47	1 55	1 0				
05 07	17 50	16 50	16 2				
04 08	31 40	31 0	30 25				
03 09	46 15	46 18	45 25				
02 10	61 0	60 38	60 13				
01 11	75 36	75 28	75 8				
12	90 0	90 0	90 0				

Lat. 86 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♐ ♒	♑
12	90 0	90 00	90 00	90 0			
	S	S	S				
11 01	74 32	64 38	74 40	74 55			
10 02	59 10	59 10	59 24	59 49			
09 03	43 40	43 55	44 10	44 51			
08 04	28 30	28 50	29 10	29 51			
07 05	13 30	13 50	14 30	14 47			
	N	N	N				
06 06	1 0	1 30	0 50				
05 07	17 0	16 30	15 50				
04 08	31 30	31 10	30 18				
03 09	46 10	46 0	45 20				
02 10	60 45	60 30	60 10				
01 11	75 30	75 24	57 7				
12	90 0	90 0	60 0				

Lat. 87 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♒ ♐	♑
12	90 0 S	90 0 S	90 0 S	90 0			
11 01	74 40	74 45	74 45	74 56			
10 02	59 25	59 25	59 34	59 50			
09 03	44 0	44 15	44 25	44 52			
08 04	28 40	29 10	29 20	29 53			
07 05	13 55 N	14 5 N	14 36 N	14 49			
06 06	0 50	1 0	0 40				
05 07	16 35	16 0	15 40				
04 08	31 5	30 50	30 14				
03 09	46 0	45 50	45 15				
02 10	60 30	60 23	60 7				
01 11	75 25	75 18	75 4				
12	90 0	90 0	90 0				

Lat. 88 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♒ ♐	♑
12	90 0 S	90 0 S	90 0 S	90 0			
11 01	74 52	74 50	74 50	74 57			
10 02	59 38	59 48	59 48	59 52			
09 03	44 30	44 35	44 46	44 55			
08 04	28 47	29 40	29 40	29 55			
07 05	14 17 N	14 35 N	14 48 N	14 55			
06 06	0 25	0 40	0 25				
05 07	16 0	15 40	15 30				
04 08	30 45	30 30	30 9				
03 09	45 40	45 30	45 10				
02 10	60 20	60 15	60 4				
01 11	75 15	75 12	75 3				
12	90 0	90 0	90 0				

Lat. 89 Deg.

	♋	♊ ♌	♉ ♎	♈ ♎	♐ ♏	♑ ♒	♓
12	90 0 S	90 0 S	90 0 S	90 0 S			
11 01	74 55	74 58	74 55	74 59			
10 02	59 50	59 55	59 56	59 57			
09 03	44 45	44 50	44 53	44 57			
08 04	28 56	29 50	29 50	29 58			
07 05	14 39 N	14 48 N	14 56 N	14 58			
06 06	0 10	0 20	0 15				
05 07	15 30	15 20	15 12				
04 08	30 25	30 15	30 5				
03 09	45 15	45 15	45 5				
02 10	60 10	60 7	60 2				
1 11	75 5	75 6	75 1				
12	90 0	90 0	90 0				

Lat. 90 Deg.

	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♏	♑ ♒	♓
12	90 0 S	90 0 S	90 0 S				
11 01	75 0	75 0	75 0				
10 2	60 0	60 0	60 0				
09 03	45 0	45 0	45 0				
08 04	30 0	30 0	30 0				
07 05	15 0	15 0	15 0				
06 06	0 0 N	0 0 N	0 0 N				
05 07	15 0	15 0	15 0				
04 08	30 0	30 0	30 0				
03 09	45 0	45 0	45 0				
02 10	60 0	60 0	60 0				
01 11	75 0	75 0	75 0				
12	90 0	90 0	90 0				

CHAP. II.

Containing the Deſcription, Conſtruction and Uſe of the foregoing Tables of Altitude.

THE Tables conſiſt of Eight Columns; in the firſt whereof are contained all the Hours both before and after Noon; and in the other ſeven are the Degrees and Minutes of the Altitude of the Sun at its entrance into the 12 Signs; and at the head of each Table is the degrees of Latitude of the place from One Degree to Ninety.

As for Example:

Suppoſe I would know what Altitude the Sun hath at Nine of the Clock in the Morning when he enters the ſign ♋ in the Latitude 43 deg. look for the Latitude of 43 deg, and againſt 9 of the Clock, and under ♋ you will find 48 deg. 17 min. and ſuch will be the Altitude of the Sun in the beginning of ♋ at 9 of the Clock in the Latitude of 43 deg. In like manner you will find, that

				d.	*m.*
when the Sun enters into	♊ or ♌	his Altitude at	11	will be found to be 63	57
	♉ or ♍		10		49
	♈ or ♎		09		31
	♓ or ♏		08		12
	♐ or ♒		12		26
			01		57
			02		10
			03		08
			04		52
					48

Their Conſtruction.

THE Calculation of theſe Tables of Altitude are performed by the Rules which Mr *Collins* lays down in his Sector on a Quadrant; which Canon is as followeth:

As

As the Square of the Radius is to the Rectangle of the Co-ſines both of the Latitude and of the Declination; So is the ſine of the Hour from ſix to a fourth ſine, which in Summer the ſum of the fourth ſine, and the Suns Altitude at ſix, is the Altitude ſought; but in the Winter, the difference between this fourth ſine and the Suns depreſſion at ſix, is the Altitude ſought.

Therefore firſt calculate the Suns Altitude at ſix, by a Table of Natural ſines, which reſerve on a piece of Paper or Card; then to the co-ſine of the Latitude of the place, add the co-ſine of the Suns Declination, their ſum will be a fixed Log. for that declination and latitude: unto which add the ſine of the hour from ſix, and their ſum will be a ſine; the natural ſine of that Logarithmetical ſine being added to the natural ſine of the Altitude at ſix, the Sum will be the natural ſine of the Altitude, and their difference will be the Altitude for ſo many hours before ſix.

Note, You muſt reckon your Hour from ſix before and after Noon, and it will be beſt to uſe a Table of Sines and Tangents, that hath the natural Sines and Tangents ſtanding againſt the artificial, and then it will be done with eaſe.

For the Suns Altitude at Six for the Lat. of London.

The Canon is,

As the Radius is to the Sine of the Suns declination, ſo is the ſine of the latitude of the place to the ſine of the Altitude at ſix.

By Natural Sine thus;

As Radius	Sine 23 30	Sine 51 32	Sine Altit. 18 12
1000000	399015	7829702	3124174
	78297 02		

7980316
279311060
35911422
7980316
31921264
27931106

1,0000000 3124174|8 072916(

This

This Natural Sine 3124174, must be reserved on a piece of Paper or Card; then,

The Co-sine of the Declination is——————99623428
The Co-sine of the Latitude is——————97938317

The fixed Log. is——————197561745
Let the Hour from 6, be 30 degrees,
That's 2 hours before & after 6, the sine thereof, add 96989700

Their sum is——————94551145
The natural sine against it, is——————2851308
The natural sine of the Altitude at 6, is——————3124174

The natural sine of the Altitude 36 *d.* 42 *m.*——————5975482 Sum.
The natural sine of the Altitude 1 *d.* 34 *m.*——————272866 Diff.
Which are the two Altit. for two hours before and after 6 in Summer.

Another Example for the same Latitude and Declination.

Let the Hour be 60 deg. that is 4 hours before and
after 6, the sine thereof, is——————99375306
The fixed Log. add——————97561745

Sum——————196937051
The natural sine against it, is——————4939419
The natural sine of the Altitude at 6——————3124174

The natural sine of 53 *d.* 45 *m.*——————8063591 Sum.
The natural sine of 10 *d.* 24 *m.*——————1805245 Diff.
These two Altitudes being thus found, are the Altitudes for Ten of the Clock in Summer and Winter.

For note, the 10 *d.* 24 *m.* is the depression of the Sun in Summer for 2 a clock in the Morning, and is the Altitude for 10 of the Clock in the Winter, when the Sun hath as much South-declination: After this manner were all the Tables of Altitude calculated; and let the Reader judge whether it hath not required much Time and Pains.

Now follows a Table for the Latitude of *London*

A Table shewing what Altitude the Sun hath at every Hour and half Hour of the Day at his Entrance into every of the Twelve Signs.

	♋	♊ ♌	♉ ♍	♈ ♎	♐ ♏	♑ ♒	♓
12	61 59	58 41	49 59	38 28	26 57	18 15	14 57
½	61 23	58 08	49 32	38 01	26 37	17 56	14 50
11 01	59 42	56 33	48 30	36 56	25 37	17 04	13 48
½	57 04	54 06	46 01	35 04	24 01	15 36	12 23
10 02	53 45	50 55	43 11	32 36	21 49	13 36	10 28
½	49 54	47 12	39 47	29 34	19 06	11 06	08 03
09 03	45 42	34 07	35 51	26 05	15 57	03 11	05 13
½	41 16	38 45	31 49	22 15	12 23	04 51	01 59
08 04	36 41	34 14	27 28	18 08	08 32	01 13	
½	32 04	29 37	22 56	13 56	04 25		
07 05	27 23	24 56	18 18	09 17	00 05		
½	22 46	20 17	13 39	04 39			
06 06	18 12	15 42	09 00				
½	13 46	11 13	04 24				
05 07	09 30	06 52					
½	05 24	02 42					
04 08	01 34						

The

The Description, Use and Construction of the Tables of Azimuth.

This Table also consisteth of Eight Columns: The first contains all the Hours both before and after Noon; and in all the other are the Degrees and Minutes of the Suns Azimuth from the East at the Entrance into every of the twelve Signs, as the Titles at the Head thereof do signifie.

The Use.

If you would know what Azimuth from the East the Sun shall have at 9 or 3 of the Clock when the Sun enters ♑ or ♉ in the Latitude of 39 degrees, look for the latitude of the Place among the Tables of Azimuth, and against 9 and 3, and under ♉ and ♑ you will find 22 7, and such Azimuth shall the Sun have from the East towards the South.

When the Sun enters into	♋ ♊ ♌ ♎ ♍ ♐	The Azim. at	10 02 / 9 03 / 7 05 / 11 01	will be found to be	22 35 S. / 12 44 S. / 09 34 S. / 71 19 S.

Its Construction.

IF you will find the Azimuth for any time, you must find by the Tables of Altitude the Suns Altitude for that Time and Latitude, then the Canon will be,

As the Co-sine of the Suns Altitude, Is to the Co-sine of the Declinat.
So is the Sine of the Hour from Noon, To the Co-sine of the Azim.

As for Example.

As the Co-sine of the Altitude,	55 46	*Co. Ar.*	00826240
Is to the Sine of the Hour,	60 00		99375316
So is the Co-sine of	23 13		99723845
To the Co-sine of the Azimuth	20 30		99925301

And such is the Suns Azimuth from East towards the South.

A Table shewing the Suns Azimuth from the East towards the North or South for every Hour and half Hour of the Day at his Entrance into every of the Twelve Signs.

	♋	♊ ♌	♉ ♍	♈ ♎	♓ ♏	♑ ♐	♒
12	90 0 S	90 0 S	90 0	90 0	90 0	90 0	90 0
½	75 38	76 36	78 50	80 20	82 3	82 20	82 50
11 01	62 4	64 0	67 47	71 8	73 38	75 15	75 47
½	59 48	52 20	57 19	62 19	65 54	68 7	69 1
10 02	39 9	42 3	47 55	53 36	58 10	61 8	62 11
½	28 17	32 49	39 9	45 34	50 50	54 21	55 43
09 03	21 30	24 44	31 13	38 4	43 58	47 56	49 22
½	14 34	17 23	23 50	31 1	37 17	41 39	43 18
08 04	08 0	10 30	17 3	24 20	31 0	35 38	
½	01 50 N	04 22 N	10 37	13 54	24 48		
07 05	04 15	01 34	04 30 N	11 54	18 50		
½	09 38	07 16	01 23	05 54			
06 06	15 8	12 54	07 12				
½	20 36	18 26	13 0				
05 07	26 3	24 3					
½	31 41	29 47					
04 08	37 24						

CHAP. III

How to place the Parallels of Declination upon an Equinoctial Plane.

THis Plane doth cut the Axis of the World at right Angles, and the Hour-lines do meet at the Center at equal Angles; which Center doth repreſent the Pole of the World, and all the Parallels muſt of neceſſity be perfect Circles, the leaſt about the Center, and the greateſt near the Limb. The Sun cannot ſhine all the year upon theſe ſorts of Dyals, but only from the 10*th.* of *March* to the 10*th.* of *September*, on that which doth reſpect the North-pole; and from the 10*th.* of *September* to the 10*th.* of *March*, on that which doth reſpect the South-pole; therefore if you divide the perpendicular ſtyle into twelve equal parts; and then look what Altitude the Sun will have when he enters *Cancer*, in that Latitude where this Dyal doth ſtand as a Horizontal Dyal, which is the Latitude of 90 degrees, and the Altitude of the Sun is equal to the Declination; therefore enter the Table of right and contrary ſhadows with the Altitude of the Sun, with the degrees at the Head, and minutes on the left hand of the Table, called Horizontal ſhadows, and at the Angle of meeting, you will have the length of the ſhadow in the ſame parts as the ſtyle is divided into; as for example, In the latitude of 90 degrees the Sun hath when he enters ♋, 23 deg. 21 min. of Altitude; with which, if you enter the Table of right and contrary ſhadows, with the degrees at Head, and the minutes on the left hand at the angle of meeting, you will find 27 parts, and $\frac{25}{60}$ of thoſe parts, which will be the ſemi-diameter of that Circle; then take this 27 $\frac{25}{60}$ of the ſame ſcale that belongs to the perpendicular ſtyle, and ſetting one foot of your Compaſſes on the Center of the Dyal, deſcribe a Circle, and that will be the Parallel of ♋; and ſo muſt you do for all the reſt of the Parallels; which is very eaſie. After the ſame manner may you inſert what Parallel of Declination you pleaſe (always noting that the Declination of the Sun is equal to the Altitude in the Latitude of 90 degrees) as alſo any day of the Month or Feſtival Day, only having regard to what Declination the Sun hath at that time.

Note, The Sun never ſets in the latitude of 90 degrees all the time it is on the North-ſide of the Equator; and by that means it is continual

Day from the 10*th.* of *March*, to the 12*th.* of *September*; but in all other Latitudes, if it doth not exceed 67 deg. 30 min. the Sun doth ſet. And therefore it will be needful to find a horizontal line proper to this Plane when it ſtands in thoſe latitudes that the Sun doth ſet in.

To draw the Horizontal Line proper to this Plane.

The Horizontal Line proper to this Plane, muſt lie in the ſame Plane with the top of the perpendicular ſtyle; and to find the point upon the Meridian-line S N, through which this line muſt paſs, depends upon a proportion; which is this;

As the Co-ſine of the latitude of the place
Is to the log. of the length of the perpendicular ſtyle,
So is the ſine of the latitude of the place,
To the log. of the diſtance of the ſaid Point from the foot of the ſtyle upon the Meridian; from which if the Plain reclines, place from A to S, but if it inclines, then place it upon the Meridian on the other ſide the foot of the perpendicular ſtyle. This line muſt be drawn parallel to the line of Eaſt and Weſt, which is the ſix of the Clock hour-line, which will be the line P S Q, beyond which line the Tropicks or Parallels of declination, or any other Furniture need not be extended.

To draw the Azimuth on this Plane.

Firſt, you muſt find a Point in the Meridian which doth repreſent the Zenith-Point; the Proportion for finding of it is this:

As the ſine of the latitude of the place
Is to the log. of the length of the perpendicular ſtyle,
So is the co-ſine of the latitude of the place
To the log. of the diſtance of the Point from the foot of the perpendicular ſtyle; which diſtance being placed from the foot of the perpendicular ſtyle from A to V, in all reclining planes; but in all inclining Planes you muſt place it on the contrary ſide.

Then for the diſtance of the top of the ſtyle to the Point S, the Proportion will run thus:

As

As the ſine of the latitude of the place
Is to the log. of the diſtance of the foot of the ſtyle and horizontal line,
So is the Radius
To the log. of the diſtance of the top of the ſtyle to the Horizontal line.

Then for the Azimuths diſtance from the Point S in the horizontal line, the Proportion will run thus:

As the log. of the laſt diſtance found,
Is to the Radius,
So is the Tangent of 11 15 for the Azimuth S by E.
To the log. of the diſtance from S. in the horizontal line:

And ſo muſt you do for all the Azimuths on the ſide S. on the horizontal line.

The length of the perpendicular ſtyle will be 12 inches,
The diſtance of S. from the foot of the ſtyle A 15 ..
The diſtance of the top of the ſtyle from the horizontal line will be found to be 19 inches $\frac{1}{10}$.

And the diſtance of the Azimuths on the horizontal line from the Point S. will be found to be as in the following Table.

Azimuths.	*Diſtances in the Horizontal line*	
	Inch.	*Part.*
S by E.	3	8
SSE	8	0
SE by S.	12	9
SE	19	3
SE by E.	21	8
ESE.	40	0
E.	*Infinite.*	

Theſe Diſtances being placed upon the horizontal line, lay a Ruler over theſe Points and the Zenith-Point, by which draw lines, which lines will be the Azimuths deſired.

CHAP.

CHAP. IV.

How to describe the Tropicks and other Circles of Declination in a Polar Plain.

IN all Polar Plains, whether they be parallel to the Meridian, or to the Circles of the Hour of 6, or otherwise declining, the Equinoctial will be a right line, but the Tropicks and other Circles of Declination will be the sections of an Hyberbola.

And to describe them, you must first consider the length of the perpendicular style, the declination of the Parallel, and the Angle at the Pole between the substyle and the hour-line whereon you do intend to describe the Parallel, and if you would find where the Parallel doth cross the substyle, the Proportion will run thus;

As the Tangent of 45 degrees,
Is to the Tangent of the Declination of the Parallel,
So is the length of the style in parts,
To the distance of the Parallel from the Equinoctial.

To find the distance of the Parallel that doth cross any other of the hour-lines, there must first be found the distance of the top of the style from the intersection of the hour-lines and the Equator; to do which, you have the length of the perpendicular style and the hour distant from the substyle, otherwise called the Angle at the Pole; the Proportion will run thus;

As the co-sine of the Angle at the Pole,
Is to the Radius,
So is the Log. of the length of the style,
To the Log. of the distance of the top of the style from the hour-line.

When you have found this distance, then you will have the declination of the Parallel from the Equator, and the last distance found, to find the distance of the Parallel from the Equator upon each hour-line, the Proportion will go thus:

As the Radius
Is to the Tangent of the declination,
So is the log. of the distance last found,
To the log. of the dist. of the parallel from the Equator, which dist. being found for every hour and quarter of an hour, may be placed in the Table; as followeth.

The

The Table for the Polar Dyal.

Hours.	*Angle at the Pole.*	*Tangen In.Par.*	*Secant* ♈ ♎	*Declin* ♊ ♍ 11 30	*Declin.* ♊ ♍ 20 12	♋ ♑ 23 30
12	00 00	00 00	10 00	02 03	03 68	04 33
11 01	15 00	02 68	10 35	02 10	03 81	04 50
10 02	30 00	05 77	11 55	02 34	04 24	05 02
09 03	45 00	10 00	14 14	02 87	05 20	06 15
08 04	60 00	17 32	20 00	04 07	07 36	03 70
07 05	75 00	37 32	38 64	07 86	14 20	16 80
06 06	90 00	*Infinit.*	*Infinit.*	*Infinit.*	*Infinit.*	*Infinit.*

In this Dyal the Perpendicular Style is made Ten inches, and may be seen by *Fig.* 2.

A Table for an East and West Dyal.

Hours from subſtyl.	*Angles at the Pole.*	*Hours diſt. at ſubſtyl.*	*Diſtan. from top of ſubſt. to H. line.*	*Declin* ♈ ♎	*Declin* ♉ ♍	*Declin* ♊ ♌	*Declin* ♋ ♍
			Declin 00 00	11 30	20 12	23 50
06 06	00 00	00 00	10 00	02 03	03 68	04 35
	03 45	00 65	10 02	02 04	03 69	04 36
	07 30	01 32	10 09	02 05	03 71	04 39
	11 15	01 99	10 20	02 07	03 75	04 43
07 05	15 00	02 68	10 35	02 10	03 81	04 50
	18 45	03 39	10 56	02 15	03 89	04 59
	22 30	04 14	10 82	02 20	03 99	04 70
	26 15	04 93	11 15	02 26	04 10	04 85
08 04	30 00	05 77	11 55	02 34	04 24	05 02
	33 45	06 68	12 03	02 44	04 42	05 23
	37 30	07 67	12 60	02 56	04 64	05 48
	41 15	08 77	13 30	02 70	04 89	05 78
09 03	45 00	10 00	14 14	02 87	05 20	06 15
	48 45	11 40	15 17	03 08	05 58	06 60
	52 30	13 03	16 43	03 34	06 04	07 14
	56 15	14 97	18 00	03 66	06 62	07 83
10 02	60 00	17 32	20 00	04 07	07 36	08 70
	63 45	20 28	22 61	04 60	08 32	09 83
	67 30	24 14	26 13	05 31	09 61	11 36
	71 15	29 45	31 11	06 33	11 45	13 53
11 01	75 00	37 32	38 64	07 86	14 20	16 80
	78 45	50 27	51 26	10 43	18 89	22 28
	82 30	75 96	75 61	15 58	28 10	33 31
	86 15	152 57	152 90	31 10	56 26	66 48
12	90 00	*Infinite.*	*Idfinite.*	*Infinit.*	*Infinit.*	*Infinit.*

This Dyal hath its perpendicular Style 10 Inches, and may be ſeen by *Fig.* 3.

When

When you have placed the ſeveral Diſtances as in the Table, then repair to your Polar Dyal, your perpendicular ſtyle being 10 Inches, or any other parts, with a Scale of the ſame equal parts that the Style is made from, or with a Sector opened (that hath a line of Lines) to the height of the ſtyle, and take the ſeveral diſtances againſt each hour, as they ſtand in the Table, and place them on both ſides the Equator, and through thoſe Points draw a line, ſo that it may not be ſtraight, nor make Angles, but ſo as it may ſeem to be an Arch.

For Example, Dyal 2.

Look in the Table belonging to the Eaſt and Weſt Plane the diſtance of ♋ and ♑ from the Equator upon the hour of 6, (that being the place of the ſubſtyle of this Dyal, and through the middle of the Plane doth paſs the Equator, being elevated to the height of the Equator in the Heavens) and you will find it to be 4 inches and 35 parts of 100, and place it from the foot of the ſtyle C, to *d*, and the diſtance 4 inches, and 50, the firſt hour from 6, and place it from *e* to *f*, that being the diſtance of ♋ from the Equator on that hour; do ſo of all the reſt, as you find them in the Table, both for ♋, and all the reſt of the Signs, and draw the lines as aforeſaid, ſo that they make no Angles; and thoſe lines ſo drawn, ſhall be the Signs; and in the ſame manner may you deſcribe any Parallel of Declination at your pleaſure.

CHAP. V.

To deſcribe the Parallels of the Length of the Day on a Polar or Meridian Plane.

THE Length of the Day, when the Sun is in the Equator, that is, when he enters ♈ or ♎, is 12 ho. and this holdeth in all Latit. but at other times of the Year, when the Sun hath any Declination, the length of the Day doth vary according to the latitude of the place; wherefore the latitude of the place being known, we are firſt to find the Declination of the Sun agreeing to the length of the Day.

Therefore you muſt firſt conſider the difference between the length

of the Day proposed, and an equinoctial Day; and turn the time into degrees and minutes by allowing for an hour 15 degrees, and for a minute 4 minutes; the Proportion will go thus;

As the Radius
Is to the sine of half the difference,
So is the co-tangent of the latitude
To the tangent of the declination.

By which Proportion the Sun will be found to have 16 *d.* 55 *m.* declination, when the Day is 9 or 15 hours long; and 21 *d.* 40 *m.* when the Day is 8 or 16 hours long; and 11 *d.* 38 *m.* when the length of the Day is 10 or 14 hours; and 5 *d.* 56 *m.* when the Day is 11 or 13 hours long.

Thus having found the declinations for the several lengths of the Day, then may you insert them after the same manner as you did describe the Signs and the Parallels of the declination; and after the same manner you may describe the Parallels of those Circles to which the Sun is vertical, and the Parallels of the principal Feasts; that is, those that are fixed, as, *Christmas-Day*, *Lady-Day*, *Midsummer-Day*, or any other day of the Month that doth depend upon the declination of the Sun; several Examples of which you have in the Appendix.

CHAP. VI.

How to draw the unequal Hours, commonly called the Planetary Hours on the Polar and Meridian Plane.

THE *Jews* divided their Artificial Day and Night, whether longer or shorter, always into 12 hours; and began their Account at Sun-rising for the Day, and at Sun-setting for the Night, as we do at Mid-day and Mid-night; so that their first hour began at Sun-rising, and their sixth hour at Noon, and the twelfth hour at Sun-set.

To describe these hour-lines on these sorts of Planes, first draw the common hour-lines, with the Halves and Quarters, and also the Equator and Tropicks, as before; then describe the two occult Parallels of the length of the Day, one for 9 hours, and the other for 15 hours; then by drawing a straight line for the first unequal hour through 5 hours, 45 minutes in the parallel of 15 hours, and through 8 hours

15

15 min. in the Parallel of 9 hours, this ſtraight line ſhall paſs directly through 7 hours 0 min. in the Equator, and ſo cut off a twelfth part of the Arch above the Horizon, both from theſe two Parallels and the Equator, and being continued unto the Tropicks, it ſhall alſo cut off about a twelfth part from them and all the reſt of the Parallels of declination, without any ſenſible Error. In the like manner may you draw the ſecond unequal hour through 7 hours in the Parallel of 15 hours, and 8 hours in the Equator, and 9 hours in the Parallels of 9; and ſo of all the reſt, as in the Table following.

Hours.	15	*Equat.*	9
0	4 30	6	7 30
1	5 45	7	8 15
2	7 00	8	9 00
3	8 15	8	9 45
4	9 30	10	10 30
5	10 45	11	11 15
6	12 00	12	12 00
7	1 15	1	0 45
8	2 30	2	1 30
9	3 45	3	2 15
10	5 00	4	3 00
11	6 15	5	3 45
12	7 30	6	4 30

CHAP. VII.

How to draw the Babyloniſh *and the* Italian *Hours on the two former Planes.*

Fig. 1, 2.

THE *Babyloniſh* Hours are accounted the equal Hours from Sun-riſing; for at what time ſoever at all times of the Year the Sun appears or riſes above the Horizon, that is the firſt hour of the day; to draw them after, you have deſcribed the Parallel of 16 hours, and the Parallel of 8 hours and the Equator; then the firſt hour is drawn through the common hour of 5, in the Parallel of 16 and 7 in the Equator, and 9 in the Parallel of 8. So likewiſe the ſecond hour muſt be a ſtraight Line through 6 in the Parallel of 16, and 8 in the Equator, and 10 in the Parallel of 8; and ſo of all the reſt, as you may ſee the Table following.

Length of the Day.						
	8 *Hou.*		12 *Ho.*		16 *Ho.*	
1	9	0	7	0	5	0	13
2	10	0	8	0	6	0	14
3	11	0	9	0	7	0	15
4	12	0	10	0	8	0	16
5	1	0	11	0	9	0	17
6	2	0	12	0	10	0	18
7	3	0	1	0	11	0	19
8	4	0	2	0	12	0	20
9	5	0	3	0	1	0	21
10	6	0	4	0	2	0	22
11	7	0	5	0	3	0	23

The *Italian* Hours are accounted from the preceding Sun-ſet, and are numbred by 1, 2, 3, 4, &c. from Sun-ſet.

The ſame Table will ſerve to deſcribe them for they are to be drawn through

through the ſame Points, that is, a right line drawn through 5 in the Parallel of 16, and 7 of the Equator, and 9 in the Parallel of 8, ſhall be the hour of One, and through 3 in the Parallel of 16, and 5 in the Equator, and 7 in the Parallel of 8, for the 23*th.* hour; and ſo of the reſt, as in the Table.

CHAP. VIII.

How to deſcribe the Vertical Circles in the two former Plains.

THE Vertical Circles, commonly called Azimuths, are great Circles drawn through the Zenith, by which we know in what part of the Heavens the Sun is, that is, how far the Sun is from the Meridian, towards the Eaſt and Weſt in all upright Planes, whether they be direct, or declining, or Meridian Planes, the Azimuths are parallel, and are alſo perpendicular to the Horizontal line, and the Horizontal line paſſeth through the Foot of the perpendicular ſtyle, and parallel to the Horizon of the Place. Now to find the diſtances of this Azimuth from the Foot of the ſtyle, you have the length of the perpendicular ſtyle, which in our Example is 10 inches, and the Angle of the Azimuth at the Zenith, which for the Meridian Plane, are 11, 15, for the Eaſt and by South, and Eaſt by North; and 22, 30, for the Eaſt South Eaſt, and Eaſt North Eaſt: To find the diſtance from the Foot of the perpendicular ſtyle, ſay,

As the Co-ſine of the Angle at the Zenith,
Is to the Log. of the length of the perpendicular ſtyle,
So is the Sine of the Angle at the Zenith,
To the Log. of the diſtance from the perpendicular ſtyle.

Or you may find them by this Proportion,

As the Radius,
Is to the Log. of the perpendicular ſtyle,
So is the Tangent of the Angle at the Zenith
To the Log. of the diſtance from the perpendicular ſtyle.

By

By which Proportion you will find that E. by S. will be 1 inch 99 parts; E S E. will be 4 inches, 14 parts of 100, and so of the rest, as in the Table.

Azimuths.	*Angle at the Zenith.*	*Distances from the Foot of the Style.*
East.	00——00	00——00
E by S, & E by N.	11——15	01——99
E S E, & E N E.	22——30	04——14
S E by E.	33——45	06——68
S E.	45——00	10——00
S E by S	56——15	14——97
S E E.	67——30	24——14
S by E.	78——45	50——27
South.	90——00	*Infinit.*

When you have made this Table, then if you take these Distances out of a Line of Inches, and prick them down in the Horizontal Line, on either side of the Style, and draw lines from those Points perpendicular to the Horizontal Line, but so that they may be contained between the Horizontal and the Tropicks, the Lines so drawn, shall be the Azimuths required.

CHAP.

CHAP. IX.

To describe the Parallels of Altitude on the Meridian Plane.

HAving found and placed the Azimuths on the former Plane, the the next thing that must be found before you place the Parallel of Altitude, must be the distance of the Top of the perpendicular style, from the intersections the Azimuth makes with the Horizon; which is found after this manner;

As the Co-sine of the Angle at the Zenith,
Is to the Radius,
So is the log. of the length of the style
To the log. of the distance required.

Then for the finding of the distance between the Horizon and each Parallel upon each Azimuth, you will have given the Altitude of the Sun you would describe, and the last distance found, and the Radius, it being a right angled Triangle, to find the distance required.

To find the distance between the Horizon and Parallels, the Proportion will go thus;

As the Radius
Is to the Tangent of the Altitude
So is the Log. of the distance of the top of the Style from the Azimuth,
To the Log. of the distance of the Parallel from the Horizontal line.

After this manner must you do for all the distances of the Parallels from the Horizontal line, and gather them in a Table, and they will be as follows.

A Table for the Distance of the Parallels from the Horizontal Line.

Azimuths.	*Azim.* Inc. P.	*Tang.* Inc. P.	*Sec. or par.* 45 Inc. P.	*Paral.* 15 Inc. P.	*Paral.* 30 Inc. P.
E.	00 00	10 00	10 00	02 68	05 77
E by S.	11 15	01 99	10 20	02 73	05 90
ESE.	22 30	04 14	10 82	02 90	06 14
SE by E.	33 45	06 68	12 03	03 23	06 94
SE	45 00	10 00	14 14	03 80	08 16
SE by S.	56 15	14 97	18 00	04 82	10 40
SSE	67 30	24 14	26 13	07 02	15 08
S by E.	78 45	50 27	51 26	13 73	29 60
S.	90 00	*Infinit.*	*Infinit.*	*Infinit.*	*Infinit.*

That being done, and the Horizon and Azimuths being drawn, prick down ten Inches from the horizontal line upon the East-Azimuth, and 10 Inches, 20 parts on the E by S Azimuth, and 10 Inches 82 parts on the ESE Azimuth, and 12 Inches 3 parts on the SE by E Azimuth, and 14 Inches 14 parts on the SE Azimuth, and 18 Inches 00 parts on SE by S Azimuth, and 26 Inches 13 on the SSE Azimuth, and 51 Inches 25 parts; then if you draw a crooked line through these points, that may make no angles, the line so drawn shall be the Parallel of 45 degrees from the Horizon: In like manner manner may you draw the Parallel of 15 degrees, or any other Parallel of Altitude upon an East or West Plain.

CHAP.

CHAP. IX.

How no describe the Circles of Position upon an East and West Plane.

THE Circles of Position are great Circles of the Sphere crossing each other in the common intersection of the Meridian and Horizon, and reckoned according to most Authors upon the Equator both ways from the Meridian down to the Horizon; the Use of them (particularly of those of 30 degrees, and 60 degrees distant each way from the Meridian) is chiefly for such as are Astrologically given, to shew them at all times of the day in which of the twelve Astrological Houses the Sun is.

Now the Cusps of these Houses being great Circles of the Sphere, therefore they must be straight lines; and forasmuch as the Plane lies parallel to the Meridian Circle, therefore are the Circles of Position parallel to the Horizon; and to find Points in the Equator of this Dyal that the Parallels must be drawn through, will require two Operations, the first will be to find a Number, which may be called the Co-secant of the Latitude of the place; which will be found thus:

As the Sine of the Latitude of the Place
Is to the Log. of the length of the Style in Inches and Parts,
So is the Radius
To the Log. of the Co-secant in Inches and Parts.

Having found this Secant in Inches and Parts, the second Proportion will go thus:

As the Co-sine of 30 or 60,
Is to the Log. of the Secant last found,
So is the Sine of 30 or 60,
To the Log. of the distance in Inches and Parts from the foot of the Style on the Equator.

By which proportions the Cusp of the 12th. House will be found to be distant from the foot of the Style 7 Inches and 37 Parts, and the

Cusp of the 11th. House will be found to be 22 Inches and 12 parts distant from the foot of the Style upon the Equator, through which points parallel Lines being drawn to the Horizontal line, will cut off certain Portions of the Plane, which will be the Astrological Houses: The Cusp of the 10th. House cannot be described, because the Plane doth lie in Meridian.

CHAP.

CHAP. X.

How to draw the Circles of Altitude upon any Horizontal Dyal.

THese Planes lie parallel to the Horizon, and have the Zenith-point for the Pole; therefore the foot of the perpendicular-ſtyle muſt be the Center of all the Circles of Altitude.

The Numeration of the Circles are two ways, which are moſt in uſe; the one is according to degrees and minutes; the other is according to the proportion that the height of any upright Object bears to the ſhadow of it.

First, By degrees and minutes of Altitude.

Having firſt divided the perpendicular Style into 12 equal parts, if you would deſcribe the parallel of 30 degrees, look in the Table of right and contrary ſhadows for 30 degrees on the head of the Table, and 00 minutes on the left hand, called the Horizontal ſhadow, and in the Angle of meeting you will find 20 parts and $\frac{47}{60}$ of one of thoſe parts, which is the length of the Horizontal ſhadow: take this 20 $\frac{47}{60}$, and place it upon the Meridian-line, and with that diſtance deſcribe a Circle upon the Center at the foot of the perpendicular ſtyle, and that ſhall be the Circle of Altitude of 30 degrees; and ſo muſt you do for all other Altitudes. This Table of right and contrary ſhadows was made from theſe two Proportions:

As the Sine of the known Altitude,
Is to the log. of the length of the Gnomon in 12 parts,
So is the Co-ſine of the ſame Altitude,
To the log. of the parts of the right ſhadow.

And for the Vertical Shadow.

As the Co-ſine of the known Altitude,
Is to the log. of the Gnomons length in parts,
So is the Sine of the ſame Altitude
To the log. of the Parts of the vertical Shadow.

Secondly, If you would describe any Circle of Altitude that shall tell you when the shadow is half the length of the perpendicular stile, and when it is twice the length, or what proportion you please to have the shadow bear to the perpendicular style, and the same proportion will be the shadow of any Object to the Object it self: To perform which, you must first find what Altitude the Sun must have to make the shadow be in such proportion to the Object as shall be required; and to find that, the proportion will be thus,

As the log. of the parts of the shadow given
Is to the Radius or Sine of 90 degrees,
So is the log. of the length of the Gnomon in parts,
To the Tangent of the Altitude the Sun must have to make the shadow so long as shall be required.

As for Example.

Admit I would know what Altitude the Sun must have to make the shadows to be three times the length of the Gnomon; let the Gnomon be divided into 12 equal parts, and measuring the shadow thereby, you find that to be 36 equal parts, that is three times the length thereof: then say,

As the log. of 36 parts	36	*Co. Ar.*	844369
Is to the Radius,	90		100000
So is the log. of 12 parts	12		107918
To the Tangent of the Suns altitude	18 25		952287

And such Altitude will the Sun have when the length of the shadow is three times the length of the Objects height.

And accordingly may you find any other proportional parts: The most that are in Use are these that follow, and have the Suns Altitude ready calculated.

					d. m.
	10		1		7 7
	6		1		9 27
	5		1		11 18
	4		1		14 2
	3		1		18 26
If then you would have the length of the shadow to be in proportion to the height of the Object, as	2		1		26 33
	3	Is to	4	The Suns Altitude must be	33 41
	2		3		36 52
	5		4		38 35
	4		5		45 0
	3		4		51 29
	4		3		53 7
	3		5		56 19
	1		2		58 2

Having got the Altitude according to the Proportion of the Shadow, enter the Table of right and contrary shadows with the Horizontal shadow on the left hand, and the Altitude at top, and the Angle of meeting will give you the Parts, and then describe them as you did before.

CHAP.

CHAP. XI.

To describe the Parallels of Altitude on a South-plane.

IN all upright Planes, whether they be direct or declining Verticals, these Parallels will be conical sections, and may be drawn through their points of Intersection with the Azimuth lines, in the same manner as the Parallels of declination through their points of intersection with the Hour-lines.

To perform which, you must first find the distance between the *Nodus* (or top of the Style) and Azimuth, and the distance between the Horizontal line and the Parallel upon each Azimuth. To find the first (*viz.*) the distance between the top of the perpendicular Style and the Azimuth in the Horizontal line, there will be given the Angle at the Zenith, or the degrees of Azimuths, and the length of the perpendicular Style, to find the Distance required.

As for Example.

Let the perpendicular Style be 10 Inches, and the Angle at the Zenith be 22 deg. 30 min. that is, the S S E point of the Compass, the Proportion will be thus:

	d. m.	
As the Co-sine of the Angle at the Zenith,	22 30	9965615
Is to the Radius	90 00	10000000
	m. Inc.	
So is the log. of the length of the Style,	10 00	1000000
		11000000
		9965615
To the log. of the distance of the top of the Style, and that Azimuth	10 82	1134385

After the same manner may you find the distance of the top of the perpendicular Style from all the Azimuths that you have a mind to insert in the Dyal. These Distances found, may properly be called the Secants of the several Azimuths: Then having found all the several

ral Secants, you must proceed to find the Distance of the Parallel of Altitude from the Horizontal line upon each Azimuth; to perform which, you will have given the Parallel that you have a mind to describe, and the Secant of the Azimuth.

To find the Distance of the Horizon and Parallel in Inches and Parts, the Proportion to find their several Distances, is as follows:

As the Radius
Is to the Tangent of the Parallel,
So is the log. of the Secant of the Azimuth,
To the log. of the Distance of the Horizon and Parallel.

As for Example.

Let the Azimuth be SSE, that is 22 deg. 30 min. and let the Secant of the Azimuth be 10 Inches, and 82 Parts of 100, and the Parallel be 30 Degrees: Thus;

As the Radius	90	10000000
	Inc. P.	
Is to the log. of the secant,	10 82	3034227
So is the Tangent of the Parallel	30 *d.*	9761439
To the log. of the Parallel from the Horizontal line,	*Inc. P.* 06 24	2795666

After the same manner must you find all the Distances of the Parallels from the Horizontal line upon every Azimuth, and place them in a Table, which will stand as followeth:

A Table

A Table to find the Distances of the Parallels from the Horizontal Line upon every Azimuth.

Azimuth from South to East.	Angle. at the Zenit.	Sec. of Az. & par. 45	Paral. 30	Paral. 15	Azimuth from South to West.
	G. M.	Inc. P.	Inc. P.	Inc. P.	
S.	00 00	10 00	05 77	02 68	S.
S by E.	11 15	10 20	05 90	02 73	S by W
S S E.	22 30	10 82	06 24	02 90	S S W
S E by S.	33 45	12 03	06 94	03 23	S W S
S E	45 00	14 14	08 16	03 80	S W
S E by E.	56 15	18 00	10 40	04 82	S W by W
E S E.	67 30	26 13	15 08	07 02	W S W
E.	90 00	51 26	29 60	13 17	W.

This Table being made, describe the Dyal with the Horizon and Azimuths, and then take 5 Inches and 77 parts, and prick it down from the Horizontal line upon the South Azimuth, or Meridian; and 5 Inches and 90 parts on the Azimuth of S by E. and S by W. and 6 Inches 24 parts on the Azimuth of S S E. and S S W. and 6 Inches 94 parts on the Azimuths of S E by S. and S W by S. and 8 Inches 16 parts on the S E and S W Azimuths, and 10 Inches and 40 parts on S E by E. and S W by W Azimuth; and so of all the rest of the Distances on their several Azimuths: then if you draw a crooked line through these several Points, so that they make no Angles, the line so drawn will be the Parallel of 30 deg. In the like manner may you describe any other Parallel of Altitude you please upon a South Plane.

CHAP.

CHAP. XII.

To describe the Parallels of the Signs in the Horizontal-Plane. Dyal 4.

HAving first described the Horizontal Dyal with the Hours: then you are to look in the Table of Altitude for the same Latitude for which the Dyal was made; and there look what Altitude the Sun hath at each hour at the beginning of each Sign; then enter the Table of right and contrary shadows, with the degrees of Altitude at the Head, and the Minutes on the left hand, and at the angle of Meeting you have the length of the right shadow for that Hour and Sign that you look for; which must be prick'd down from the foot of the perpendicular style, upon the respective hours you took the right shadow from; and then draw a line through those several Points, so that they make no angle, and the line so drawn, shall be the Parallel of the Sign that the Altitude doth belong to.

As for Example.

Let there be a Horizontal Dyal for the latitude of 51 *d.* 32 *m.* If you would describe the Parallel of ♋, look in the Table of the Suns Altitude, for the same Latitude, and against 12 of the Clock, and under ♋, I find 62 degrees; these 62 degrees I enter the Table of right and contrary shadows for 62 degrees at the head of the Table, and against 00 min. on the left hand, and at the Angle of meeting you will find 6 Inches, and 23 parts of 60, which take off the same scale that the perpendic. style doth belong to, that being divided into 12 parts, and place it upon the Meridian from the foot of the perpendicular style; and for 11 and 1 of the Clock, the Altitude will be found to be 59 degrees and 43 min. then enter the Table of right and contrary shadows, as you did before, and you will find the right shadow to be 7 Inches and 1 part of 60 of an Inch; place this from the Foot of the style to 11 and 1 of the Clock, and for 10 and 2 of the Clock, the Altitude will be found to be 53 deg. and 45 min; that being found in the Table of right and contrary shadows, the right shadow will be found to be 8 inches 48 parts of 60 of an inch; and so do for all the rest of the hours under ♋, and draw lines through all those Points, so that they make no Angle, that line so drawn, will represent the Parallel of ♋, and so may you do for all the rest of the Parallels.

CHAP. XII.

To draw the Parallels of the Signs on any South-Plane.

A South-Dyal is a Horizontal Dyal in that Latitude that is equal to the height of the Style, and the placing on the Parallels are the same with the Horizontal in all respects; only note, that the Parallel of ♋ doth lie furthest from the Center, and the Parallel of ♑ doth lie next the perpendicular style, and you must use that Table of Altitude of that Latitude that is equal to the height of the Style.

As for Example.

Admit you had a South-Dyal drawn for the Latitude of 51 00, and you were minded to draw the Parallels of the Signs on it, you must look for that Table of Altitude of the Sun that is equal to 39 degrees, the complement of the latitude of the place, or height of the Style; that done, you must enter the Table of right and contrary shadows, with the degrees at the Head of the Table, called the Suns Altitude, and with the minutes on the left hand, called Vertical shadows; for in all Horizontal Dyals you must use the Horizontal shadow, and in all South-planes you must use the Vertical shadow; and use it in all respects as you did in the Horizontal Dyal.

CHAP. XIV.

Shewing how to inſcribe the Parallels of the Length of the Day on a Horizontal Plane.

HAving found what Declination the Sun hath when the Days have 16 equal hours in length, as you were ſhewed in the placing of the ſame Parallel in the Eaſt and Weſt Dyals, where you have a Table for every equal hour of the length of the Day; the next thing that you have to do, is to find the Altitude of the Sun to each of thoſe Declinations for every hour of the Day.

The manner of making ſuch a Table, you have in the Conſtruction of the Table of Altitude before-going: Then having a Table of Altitude to each Declination, you may proceed to place in the Parallels of the length of the Day the ſame way as you did the Parallels of the Signs in the Horizontal Dyal before, and the Parallels of the length of the Day are inſerted in a South Dyal, as the Parallels of the Signs are.

CHAP. XV.

Shewing how the Italian *and* Babyloniſh *Hours may be deſcribed upon the Horizontal and South Plane.*

THE manner of placing of theſe Hours, are the ſame as was ſhewed in the Seventh Chapter in all Reſpects; there being a Table which is general for all Dyals: For having deſcribed the Parallel of 8 and 16 hours (*viz.*) the length of the Day, and the Equinoctial, then the firſt hour will paſs through 5 of the Parallel of 16, and 7 of the Equator, and 9 of the Parallel of 8 hours; and ſo of all the reſt of the hours, as it ſhewed in the Seventh Chapter.

The *Jewiſh* Hours, commonly called the Planetary Hours, are ſhewed in the 6th. Chapter, and a Table is there fitted for all Dyals, and the manner of inſerting of them are the ſame; and to repeat the ſame over again, is needleſs.

CHAP. XVI.

Shewing how to inſert the domifying Circles, commonly called the Circles of Poſition, on a Horizontal and South Plane.

THeſe being great Circles of the Sphere, they will be ſtreight lines on any Plane; their ſituation is at the common interſection of the Meridian with the Horizon, and are reckoned according to the Rational way of *Regiomontanus*, from the Meridian downwards to the Horizon at 30 and 60 degrees, which with the Meridian and Horizon are the Cuſps of the Houſes above the Horizon; ſo that theſe Circles being inſcribed upon any Dyal-Plane, it may be known in which of the Twelve Houſes the Sign is at any time of the Day, to inſcribe them upon a Horizontal Plane.

Firſt, You muſt conſider where the Hour-line of 10 doth croſs the Equator, and from that point draw a line parallel to the Meridian; and that line ſo drawn, will be the Cuſp of the 11th. Houſe; the Meridian being the Cuſp of the 10th; and where the hour-line of 8 doth croſs the Equator, from that point draw a line parallel to the Meridian, and that line ſo drawn, will be the Cuſp of the 12th. Houſe, and the Horizontal line on the ſame ſide ſhall be the Cuſp of the Aſcendant.

Alſo note where the Hour-line of 2 doth croſs the Equator, and a line drawn from that point parallel to the Meridian, will be the Cuſp of the 9th. Houſe; and where the hour-line of 4 doth croſs the Equator, a parallel line being drawn from that point to the Meridian, will be the Cuſp of the 8th Houſe; the Horizontal line on that ſide will be the Cuſp of the 7th. Houſe: So have you the Cuſps of 6 of the 12 Houſes; the other 6 being under the Earth.

To inſcribe them upon a South-Dyal.

The Lines do meet in a Center, which will always be the interſection of the Meridian and Horizontal line; therefore note where the hour-lines of 10 and 8 do croſs the Equator, and alſo where the 2 and 4 hour-line doth croſs the Equator; and lines being drawn through the interſection of the Equator to the croſſing of the Meridian line with the Horizontal, theſe lines ſo drawn, will be the cuſp of the ſeveral Houſes, as in the Horizontal Dyal.

Note

Note alſo, that let the Dyal be never ſo irregular, that is, let it decline, or decline and recline; ſo that the Meridian of the Dyal doth in any place thereof interſect the Horizontal line, this laſt Rule is general: but becauſe in a Horizontal Dyal the Meridian doth interſect the horizontal line at the North and South end of the Plane, therefore theſe Circles do lie parallel to the Meridian, and the Eaſt and Weſt Dyals lying parallel themſelves to the Meridian, therefore theſe Circles lie parallel to the Horizontal line.

CHAP. XVII.

Of the Meridians of other Countries, and how to inſert them into any Sun-Dyal.

FIrſt, you muſt know the difference of Longitude between the two Countries in time, allowing for every 15 degrees an hour; and whether the remote Countrey lie Eaſtward or Weſtward from the place the Dyal is made for.

If the remote Countrey lie to the Eaſtward of the place, then it is Noon ſooner than it is at the place the Dyal doth ſtand in; if to the Weſtward, then it is Noon later 4 minutes of time for every degree of Longitude; and for every 15 degrees an hour.

As for Example:

Boſton in *New-England*, is to the Weſt of *London* 70 degrees; Now if you do allow for every 15 degrees an hour, and for every 4 degrees 4 minutes of time, then will you find that it will not be Noon at *Boſton* till it be 40 minutes paſt four of the Clock with us here in *London*; and therefore if you make a Mark or Word where the ſhadow of the Style ſhall fall at that time of the day, it will tell you that it is Noon there; and knowing that, it is eaſily known what hour it is there at any time here.

A Table for Boston *in* New-England.

For if it be Morning.	Afternoon.		of the Clock at *London*, It is at *Boston* in *New-England*		
		9		4	20
		8		3	20
		7		2	20
		6		1	20
		5		12	20
		4		11	20
		3		10	20
		2		9	20
		1		8	20
		12		7	20
		11		6	20
		10		5	20
		9		4	20
		8		3	20
		7		2	20
		6		1	20
		5		12	20

A Table for Constantinople.

And if it be	of the Clock at London,	it is at Constantinople
Morning,	4	6 15
	5	7 15
	6	8 15
	7	9 15
	8	10 15
	9	11 15
	10	12 15
	11	1 15
	12	2 15
Afternoon.	1	3 15
	2	4 15
	3	5 15
	4	6 15
	5	7 15
	6	8 15
	7	9 15
	8	10 15

A Table for Jerusalem.

And if it be		of the Clock at *London*,			
Morning.	Afternoon.	it is at *Jerusalem*	Afternoon.	Morning.	
8	4	12	6	30	
9	5	1	7	30	
10	6	2	8	30	
11	7	3	9	30	
12	8	4	10	30	
1	9	5	11	30	
2	10	6	12	30	
3	11	7	1	30	
4	12	8	2	30	
5	1	9	3	30	
6	2	10	4	30	
7	3	11	5	30	
8	4	12	6	30	

A Catalogue of some of the most eminent Places in the World, with the Elevation of the Pole in each Place, and their distance in Longitude from the Merid. of London.

The Names of Places.	Diff. in Long. H. M.		El. of the P. D. M.
Aberdeen in Scotland	0 8	W	58 40
Adrianopolis in Thrace	2 4	E	43 20
Agria in Hungary	1 21	E	47 56
Aleppo in Syria	2 25	E	37 10
Alexandria in Egypt	2 36	E	30 58
Amsterdam in Holland	0 21	E	52 24
Antwerp in Brabant	0 18	E	51 12
Athens in Greece	1 51	E	37 42
Augspurg in Swethland	0 46	E	48 22
Bamberg in Franconia	0 43	E	49 57
Babylon in Chaldea	3 49	E	33 0
Barcino in Catalonia	0 10	E	40 45
Bononia in Italy	0 43	E	43 49
Bethelem in Judea	2 46	E	31 50
Bruxels in Brabant	0 16	E	50 48
Bourdeaux in France	0 12	W	45 47
Calice in France	0 0	00	50 52
Compostella in Spain	0 38	W	43 2
Constantinople in Thrace	2 18	E	43 0
Copenhagen in Denmark	0 50	E	55 43
Cracovia in Poland	1 21	E	49 58
Damascus in Syria	3 16	E	34 0
Dantzick	1 18	E	54 23
Edenburgh in Scotland	0 11	W	57 6
Ferraria in Italy	0 43	E	44 45
Frankford upon Odar	1 0	E	52 20
Frankford upon Moene	0 32	E	50 1

Names of Places.	Dist in Long. H. M.		Ele. of the P. D. M.
Fruenburg in Prussia	1 20	E	54 29
Geneva	0 26	E	45 54
Gaunt in Flanders	0 16	E	50 54
Hamburg in Holsatia	0 39	E	33 43
Hierusalem	3 5	E	32 10
Lisbone in Portugal	0 36	W	38 45
Lyons in France	0 20	E	45 16
Lubeck in Saxony	0 40	E	53 58
Magdeburg in Saxony	0 47	E	52 16
Middleburg in Zealand	0 16	E	51 30
Marpurg in Hessia	0 33	E	50 42
Mecha in Arabia	3 23	E	23 0
Madrid in Spain	0 11	W	40 45
Narbon in France	0 1	E	43 26
Naples in Italy	1 1	E	40 42
Ninive in Assyria	3 38	E	35 50
Norembergh in Germany	0 46	E	49 26
Orleans in France	0 0	E	48 8
Padua in Venice	0 49	E	36 25
Paris in France	0 2	E	48 51
Prague in Bohemia	0 56	E	50 56
Presburg in Hungary	1 0	E	48 25
Quinzoy in China	11 28	E	37 40
Ravenburg in Bavaria	0 41	E	47 45
Rome in Italy	0 50	E	42 2
Rotterdam in Holland	0 14	E	51 55
Rochel in France	0 4	W	45 49
Roan in Normandy	0 6	E	49 30
Rhodes Island	3 26	E	36 0
Salisburgh in Bavaria	0 54	E	47 42
Salveldy in Thuringia	0 44	E	50 47
Smarcanda in Tartaria	5 40	E	45 0
Scutara in Dalmatia	1 26	E	42 20
Sevil in Spain	0 22	W	37 20
Stetin in Germany	0 38	E	53 36
Smyrna in Asia	2 14	E	38 50

Stock-

Names of Places.	Diff in Long. H. M.		Ele. of the P. D. M.
Stockholm in Swethland	1 1	E	58 50
Syracuſe in Sicily	1 5	E	36 50
Theſſalonica	1 45	E	41 32
Toledo in Spain	0 14	W	39 54
Tripolis in Syria	3 0	E	34 50
Tubing in Swethland	0 38	E	48 34
Triets	0 26	E	49 50
Torge in Miſnia	0 53	E	51 33
Valentia in Spain	0 4	E	39 30
Venice in Italy	0 48	E	45 15
Vienna in Auſtria	1 5	E	48 22
Ulms in Swethland	0 42	E	48 24
Uraniburg in Denmark	0 50	E	55 54
Ulliſippo in Portugal	0 35	W	38 45
Weymar	0 46	E	51 8
Worms	0 29	E	50 25
Wittenberg in Saxony	0 52	E	51 52

A Catalogue of the most Eminent Cities and Towns in England, Ireland *and* Wales; *shewing their difference of Meridians from* London, *and the Elevation of the Pole in each Place.*

Names of Places.	Diff. of Merid. H. M.		H. of the P. D. M
St. Albans	0 1	W	51 55
Berwick	0 6	W	55 49
Bedford	0 2	W	52 18
Briſtol	0 11	W	51 32
Bolton	0 0	00	53 2
Cambridge	0 2	E	52 20
Canterbury	0 5	E	51 27
Carliſle	0 10	W	54 57
Cheſter	0 10	W	53 16
Coventry	0 4	W	52 30
Carmarthen	0 17	W	52 2
Colcheſter	0 5	E	52 4
Chicheſter	0 3	W	50 56
Darby	0 5	W	53 6
Dartmouth	0 15	W	50 32
Dublin	0 26	W	53 11
Durham	0 5	W	54 45
Ely	0 1	E	52 20
Gloceſter	0 9	W	52 0
Grantham	0 2	W	52 58
Halliſax	0 6	W	53 49
Hertford	0 1	W	51 50
Hereford	0 11	W	52 14
Hull	0 1	W	53 50
Huntingdon	0 1	W	52 19
Lancaſter	0 11	W	54 8
Leiceſter	0 4	W	52 40
Leverpool	0 10	W	53 22

Lincoln

Names of Places.	Diff. of Merid H. M.		H. of the P. D. M.
Lincoln	0 1	W	53 15
Middle of the Isle of Man	0 17	W	54 22
Manchester	0 9	W	53 24
Nottingham	0 4	W	53 3
Newark	0 3	W	53 2
Newcastle	0 1	W	55 3
Norwich	0 4	E	22 44
Northampton	0 4	W	52 18
North-Luffingham	0 3	W	52 41
Okenham.	0 3	W	52 44
Oxford	0 5	W	51 42
Peterborough	0 2	W	52 35
Richmond	0 6	W	54 26
Rochester	0 2	E	51 30
St. Michaels Mount	0 23	W	50 38
Stafford	0 8	W	52 55
Shrewsbury	0 11	W	52 48
Stamford	0 2	W	52 41
Tredagh	0 27	W	53 38
Uppingham	0 3	W	52 40
Warwick	0 6	W	52 25
Waterford	0 27	W	52 22
Winchester	0 5	W	51 10
Worcester	0 9	W	52 20
Yarmouth	0 6	E	52 45
York	0 4	W	54 0
London, *the Metropolis of* Great Britain, *lies under the Latitude of*	51 32		

CHAP.

CHAP. XVIII.

Of the Horizon of any City or Place whose Latitude and Longitude is known, and how to insert it into a Sun-Dyal.

THE Horizon of any Country is to tell what time of the Day the Sun doth rise there or set, by a line drawn on the Dyal; so that when the shadow of the Gnomon doth touch that line, at that very time the Sun shall be either rising or setting: To perform which, you having the Parallels of the Signs, and the Equator, and the Hours drawn in that Dyal you have a mind to describe these lines, then the Horizon of any Country may be put in without much trouble, thus; Admit I would insert the Horizon of *Constantinople*, the difference of longitude of that place from *London* is 34 deg. which in time gives two hours and sixteen min. therefore the Sun doth rise (when the days are 12 hours long) 2 hours and 16 min. before it doth with us, and also set 2 hours and 16 min. before it doth at *London*; therefore insert the line of Sun-setting, or West-point of the Horizon of *Constantinople*.

The West-point therefore of that Horizon is upon the Equator at 3 hours, 44 min. this is one point; then find another point upon some other parallel, as ♋ or ♍; let it be ♍ on the shortest day at *Constantinople*, the Sun setting at 4 of the Clock, and 24 min. past, that is, the day is then 1 hour 36 min. shorter than an equinoctial day, and setteth 1 hour and 36 min. sooner; therefore from the horizontal point noted before upon the Equinoctial, count 1 hour 36 min. sooner (that is, towards our 12 of the Clock) and find that hour or point of time in the parallel of ♍, and that will be a second point; having this second point in ♍, and the first point in the Equator, you may draw a straight line through them both, till it doth cut the Parallel of ♋; then have you the Horizon of Sun-setting at *Constantinople*: In the like manner may you insert the Horizon of any Country. Many ways there are to insert the Horizons of other Countries; but this being the best and easiest, I shall not trouble my self to insert more ways at this time.

CHAP.

CHAP. XIX

How to describe the Signs ascending or descending.

IF you would insert the Signs into the hour-lines, you must find out what Altitudes the intersection of the Ecliptick hath with the hour-circles (two of them at least to set them upon a Plane; but more are better, that they may serve for all cases, and to all superficies) at that moment of time when the beginning of any Sign doth ascend or descend; which will be found a hard Calculation; but the most easie way will be to find out what Amplitude the beginning of every Sign rising or setting hath, and what Altitude the Ecliptick at the same time cutteth upon the Meridian; and for Signs culminating, it must be required what Altitude the beginning of each Sign hath when it is in the Meridian, and what Amplitude also it hath at the same time upon the Horizon.

Then for the Signs ascending, if ♈ ascend, then is the Amplitude 0o, and ♍ is upon the Meridian, and so the Meridian-Altitude of ♍ is equal to the height of the Ecliptick upon the Meridian, whilst the first point of ♈ is ascending; at which time ♎ doth descend; so likewise if ♎ doth ascend, then the Amplitude will be 0o, and ♋ will be upon the Meridian; so that the Meridian-Altitude of ♋ is the Altitude of the Ecliptick upon the Meridian, whilst the beginning of ♎ is Ascendant for the other Signs, to know what Altitude the Ecliptick cuts upon the Meridian at their Ascent above the Horizon, there must be had,

First, Their Amplitude.

Secondly, The Oriental Angle, or the Angle made between the Ecliptick and Horizon at the same time.

First, For the Amplitude, the Proportion is,

As the sine of the Latitude of the place,
Is to the sine of the declination,
So is the Radius,
To the sine of the Amplitude from the East.

This

This Arch last found, being substracted from 90, gives the Amplitude from the South for Northern Signs, and the Amplitude from the North in Southern Signs.

The Oriental Angle is thus found;

As the cosine of the declination of the point ascending,
Is to the sine of the Latitude of the Place,
So is the Radius
To the sine of the Angle made between the Meridian that passeth through the Point ascending and the Horizon.

This Angle being added to the Angle made by the same Meridian and Ecliptick, give the true oriental Angle: Now the Angle made by the Ecliptick and Meridians that pass through the beginning of each Sign, are these; ♈ is 113 deg. 30 min. ♉ and ♓ are 110 deg. 38 min. ♊ and ♒ 102 deg. 16 min. ♋ and ♑ 90 deg. 00 min. ♌ and ♐ 77 deg. 44 min. ♍ and ♏ 69 deg. 22 min. ♎ 66 deg. 30 min. These are the Angles before mentioned, which in these Northern Latitudes, and while they are in the Ascendant, do look upwards from the Horizon towards the Zenith, and North-pole, or towards the Arch included between them; but their Complements must be taken in South Latitudes; and although the Oriental Angle do fall out to be obtuse, and the Tangent of it is used in the next work, whereas the Tangent doth go no further than 90 degrees, it is to be noted that any under 180 degrees, and its complement to 180 degrees, hath the same Sine or Tangent, or Secant.

Then for the Eclipticks Altitude, say,

As the Radius
Is to the Tangent of the Oriental Angle,
So is the Sine of the Suns Amplitude from the South,
To the Tangent of the Eclipticks Altitude upon the Meridian.

Now the Altitudes upon the Meridian being computed, for ♈ ♉ ♊ ♋ ♌ ♍ ♎ will be sufficient; for ♓ ascending, hath the Altitude on the Meridian, as ♉ hath when it doth ascend, and ♒ the same with ♊, and ♑ with ♋; and so of the rest. When you have framed the two Tables of Amplitudes, and Meridian Altitudes, you may by them insert the 12 Signs ascending, in this manner, with less trouble, though

though enough to piece out your Horizontal line by a returning Thred where need is, and upon it project the Amplitudes of the ascending Signs from the South, among the Morning hours; they may be projected first upon Pastebord, as the Hours and Azimuths were before, and from thence be transmitted to the Horizontal line, by Marks or Knots set thereon; then if the Meridian line be there, all is well; but if it be not upon the Dyal-superficies, you must for a time draw or stretch on in the Arch, by a Thred placed in the Plain of the Meridian, in such manner as that it may receive what is now to be inserted into the same Meridian, therefore, by help of a Semi-circle infix the several Meridian-Altitudes of the Ecliptick, and set marks at them; after this, you may without any difficulty project the several Positions of the Ecliptick, thus, stretch a Thred fixed at one end to the point of the Gnomon, to the several marks made in the horizontal line, and at every such extent let your Eye repose the Thred upon that point of the Meridian that answers to the same Sign that the Thred was extended unto in the horizontal line, so shall the shadow of the Thred shew you upon the Dyal where the line for that ascending Sign is to be drawn; and after the same manner must you project them all (12 in number) you may at the East end among the morning hours, write Signs ascending, with the Characters of those set upon each of them, which properly belong unto them; and among the Evening-hours write Signs descending, setting upon each line the Characters of those Signs that are opposite to the former, because when any Sign is ascending, the opposite is descending.

The descending Signs are put into any Dyal the same way as the ascending Signs are.

Note, All Dyals that look towards the North, must by your Semicircle project the same Meridian Altitude upwards above the horizontal line, and not downwards, as in Dyals looking towards the South.

For Signs culminating, you must first find their Meridian Altitude, which is easily done for the beginning of every Sign; for having their Declination before set down, you must, if they be Northern Signs, add the Declination to the height of the Equator (that being equal to the complement of the latitude of the place) and in South Signs substract the Declination out of the height of the Equator, the Numbers so produced will be the meridian Altitudes of the beginnings of each of the twelve Signs: Secondly, you must seek what Amplitudes the Ecliptick hath when the beginnings of the twelve Signs are in the Meridian, to which purpose also the acute Angles made between the Meridian that passeth through the beginning of each Sign, and the Ecliptick

tick must be had in readiness, and they are these, ♈ ♌ ♐ 90 deg. 30 min. ♉ ♍ ♑ 69 deg. 22 min. ♊ ♎ ♒ 77 deg. 44 min. ♋ ♏ ♓ 90 deg. 00 min. And likewise it must be noted that any Sign from ♋ to ♑, being in the Meridian, the East Amplitude of the Ecliptick from the South is less than 90 degrees, the West Amplitude more; but any Sign from ♑ to ♋ possessing the Meridian, the East Amplitude is from the South more than 90 degrees, the West Amplitude less. Now the Amplitude is found by this Proportion;

As the Radius

To the Sine of the Meridian Altitude of the beginning of any Sign,

So is the Tangent of the Angle at the Meridian (set down before for every Sign)

To the Tangent of the Ecliptick Amplitude at that time from the South.

Note, That the East Amplitude of the Ecliptick, when ♋ or ♑ are in the South, are always 90 degrees; and if you require the East-Amplitudes of the Ecliptick, when ♈ ♌ ♐ ♉ ♍ ♑ are in the Meridian, their complements to 90 deg. are the West Amplitudes of the Ecliptick for ♊ ♎ ♒ ♋ ♏ ♓, remembring the Cautions given before; and the ortive Amplitude of the Ecliptick from the South, when any Sign is culminating, is equal to the occasive Amplitudes of the Ecliptick from the North, when that Sign that is as much distant from ♋, as the forenamed Sign was culminating.

The Tables of the Ecliptick Amplitudes from the South and Meridian-Altitudes being fitted, you must now accommodate your Horizontal and Meridian lines as you did before for Ascending Signs, and then among the Morning hours, upon a piece of Pasteboard project your Amplitudes in the horizontal line for the twelve Signs, and their Meridian Altitudes into the Meridian by a Semicircle; and being thus prepared, you may project the Ecliptick severally into your Dyal-superficies, as you did the Signs Arising and Setting; and character each line with that Sign that belongs unto it, and with the Character of the opposite Sign that is in the *Imocell* at the same time.

CHAP.

CHAP. XX.

How to place the Rising, Culminating and Setting of any Fixed Star.

THE manner of inserting of those Stars that have no latitudes from the Ecliptick, is after the same manner as was shewed in the last Chapter; only whereas you found the Amplitude and Altitude for the beginning of each Sign here, you must find the Amplitude and Altitude for that degree as the Star is in; and then the work will be the same in all respects; but to place those Stars that have latitude, there must be some more trouble: and one Example will be more than all the Words can be.

Admit I would know by the shadow of the Gnomon of a Dyal when the bright Star of the Pleiades doth rise, culminate and set, this Star must be placed in ♉ 25 degrees, 39 minutes, having 3 degrees, 59 minutes, of North latitude.

First, you must give the Stars declination, which you will find to be 23 deg. 00 min. North, and also the Stars right Ascension, which will be found to be 51 deg. 42 min. then get the Stars semidiurnal Arch by this proportion;

As the Cotangent of the latitude of the Place
To the Tangent of the Declination
So is the Radius,
To the Sine of the Stars ascentional Difference:

Which being added to 90 deg. (because the declination was North, else should be subtracted) gives the Stars semidiurnal Arch for the latitude of that Place; which let be *London*, and then it will be found to be 123 deg. 15 min. This being taken out of the Stars right Ascension, always adding 360 deg. where the Subtraction cannot be made; which in this Example is but 51 deg. 42 min. and 360 deg. being added to it, makes 411 deg. 42 min. from whence subtract 122 deg. 15 min. leaves 289 deg. 27 min. the right ascension of the *Medium Cæli*, when the Star is rising; and if you add the semidiurnal Arch to the right Ascension, gives 173 deg. 57 min. the right Ascension of the *Medium Cæli*, when the Star is setting, and the right Ascension of the Star it self is the right Ascension of the *Medium Cæli*, when the Star is culminating.

Now having got these right Ascensions, you may get the Points of the Ecliptick, thus;

As the Radius,
Is to the Cosine of the Stars Declination,
So is the Tangent of the Stars right Ascension
To the point of the Ecliptick answerable.

Then for the Declination of this found Point.

As the Radius,
Is to the sine of the Stars right Ascension,
So is the Tangent of the Stars Declination
To the Tangent of the Declination of that Point.

Then for the Angle the Ecliptick makes with the Meridian.

As the Radius,
Is to the sine of the Stars Declination
So is the Cosine of the Stars right Ascension
To the Cosine of the acute Angle made by the Ecliptick and Meridian.

Then note, That if the right Ascension of the *Medium Cœli* be in the second or third Quarter of the Equator, then the East Amplitude of the Ecliptick from the South is less than 90 degrees, the West Amplitude more: but if the right Ascention be in the first or last Quarter, then is the Ortive Amplitude more than 90 degrees, the Occasive less.

Having found the right Ascension of the *Medium Cœli*, then for the Declination thereof, say,

As the Radius or sine of 90 degrees,
Is to the sine of the Suns greatest Declination, 23 *d.* 30 *m.*
So is the sine of the right Ascension of the *Medium Cœli*,
To the sine of the Declination thereof.

Having

Having found the Declination of the *Medium Cæli*, you muſt add it to the height of the Equator:

If the *Medium Cæli* be in ♈ ♉ ♊ ♋ ♌ ♍, but if the *Medium Cæli* be in ♎ ♏ ♐ ♑ ♒ ♓, then you muſt ſubtract the *Medium Cæli's* declination from the height of the Equator, and there will remain the Altitude of the *Medium Cæli*, which is the Meridian-altitude of the Ecliptick: Then for the Amplitude of the Ecliptick, at the ſame time, the Proportion will run thus;

As the Radius or ſine of 90 degrees
Is to the ſine of the Eclipticks Meridian-altitude,
So is the Tangent of the Angle between the Ecliptick and Meridian,
To the Tangents of the Eclipticks Amplitude.

In this manner alſo may the appulſe of any fixed Star to any Azimuth, or Altitude, or Meridian, or any other ſtanding Circle be computed and inſerted, if namely, the ſituation of the Ecliptick at the ſame moment be projected on the Dyal.

Theſe former things being found, will help to put on ſuch Lines as ſhew the Stars Aſcenſion above the Horizon, Deſcenſion and Culmination: The manner of putting them in, is the very ſame as was uſed before for inſerting the Signs of the Ecliptick aſcending, deſcending and culminating, ſo that more words about it will be needleſs.

Theſe are the principal Things wherewith Sun-Dyals are uſually furniſhed; therefore if the former Precepts be but well underſtood, it will be very eaſie to inſert the Coſmical, Acromical, or Heliacal Riſing and Setting of Stars, or any ſuch like Requiſite, the Uſe of each ſeveral line is ſhewed by the ſhadow of the point of the Gnomon, as it treadeth along through them; and Examples of each ſeveral Concelts you have in the Dyals that was in the late King's Privy Garden: The deſcription of each Dyal you have in the Appendix.

CHAP.

CHAP. XXI.

How to describe all manner of Furniture on any upright declining, or declining reclining, or inclining declining Dyal.

First, you must consider that all Planes in any latitude, and howsoever situated in that latitude, whether they be direct declining, reclining, inclining, or do both decline and recline, are in some one part of the World or other horizontal Planes; and look what Altitude or Elevation the style of any such oblique Dyal hath in any latitude, in that latitude will that Plane be an horizontal Plane, but under another Meridian.

Therefore you must on any irregular Dyal first draw the Hours, Halves and Quarters, as was shewed in the first Part; and then if you draw an horizontal Dyal (in dark or obscure lines, so that they may be expunged at pleasure) proper to that latitude in which the said Plane will be horizontal, accounting the Substyle-line to be the Hour-line of 12; and then upon those occult horizontal hour-lines describe what Furniture you be minded to inscribe in the Plane, whether it be the Azimuths parallels of the Suns Course or Declination, Almicanters, or any other, as you have been shewed in the foregoing Chapters, on any horizontal Dyal, and through those Points draw the section (whatever it happen to be) and afterwards expunge the horizontal Hour-lines, the Parallels so drawn shall be the true Parallels of the Suns course, upon the other Plane whether it be direct, declining, reclining, or both.

You may, if you please, draw the occult horizontal Hour-lines in other colours, so that they may be distinguished from the other Hour-lines, and that horizontal Dyal will tell you at all times the true time of the Day in that Place, let it be never so remote.

But note, this manner of way doth respect all those Dyals that have Centers; if your Dyal fall to have no Center, then the Precepts of the Polar and Meridian-Planes are to be used.

CHAP.

CHAP. XXII.

How to draw the Hour-Line on the bottom of a Box, so that a Star or other Figure may pass over them, and shew the Hour of the Day let the Plane be never so irregular (viz.) *let it be direct, horizontal, declining, reclining, or both.*

THE manner of drawing the Hour-lines is the same as was shewed on any other Dyals in the first Part; but consider, if there was an Axis or Style on this Dyal, it will pass through the Glass or Cover (for all such Dyals have a Glass Cover) the very Point where the Axis doth go through is the Place where the Star is to be placed; it may be as well a Lyons Paw, or the top of a Scepter, or a Finger of a mans Hand, or any thing that you fancy: In this manner are the Twenty Dyals that were placed on the edge of the Table of the first Piece, only the Dyals instead of being described on the bottom of the Box, are described on the Glass, and are the same only inverted.

If you be minded to place Furniture on such a Dyal without Hour-lines, such as are the sixteen Dyals that are on the edge of the Table of the second Piece of the Pyramis, then the direction of placing the Furniture in the foregoing Chapter, will be sufficient, and the style is a little Star, which is in such Dyals the Nodus of the style; but you must note, if you be not minded to have the Hour-lines with the Furniture, then you may draw them so that you may expunge them, and then you have your desire.

CHAP.

CHAP. XXIII.

How to draw a Reflected Dyal on any Wall or Cieling (whereon a Glass being placed on the Transom of a Window, or some other convenient Place Horizontal) let the Cieling be never so irregular.

A Cieling Dyal is no more than a Horizontal Dyal turned upside down, and the Spot that doth trace out the Hour-lines, is reflected from a piece of Glass fixed on the Transom, or some other Place Horizontal, and doth depend upon that Principle of the Opticks, which is, that the Angle of Incidence is equal to the Angle of Reflection; and as any direct Dyal may be made by help of a Point in the direct Axis, so may any Reflected Dyal be also made by help of any Point found in the Reflected Axis.

And in regard the Reflected Axis for the most part will fall above the Horizon of the Glass without the Window, so that no Point there can be fixed; therefore a Point must be found in the said Reflected Axis continued below the horizontal line of the said Glass, until it touch the Ground or Floor of the Room, in some part of the Meridian formerly drawn, which Point will be the Point in the Reversed Axis desired, and may be found two ways, thus;

The first is, Fix an end of a Thred at or in the Center of the said Glass, move the other end thereof in the Meridian formerly drawn below the said Glass, until the said reversed Axis be depressed below the the Horizon, as the direct Axis is elevated above the Horizon; which may be done by applying the side or edge of a Quadrant to the said Thred, and moving the end thereof to and fro in the said Meridian, until the Thred with a Plummet cut the same degree as the Pole is above the horizontal Glass, and then that Point where the end of the Thred toucheth the Meridian, either on the Floor or Wall of the Room, is the Point in the reflected reversed Axis sought: For,

The Second Way to find the Point is this, First, You must consider that the reversed Axis is as much depressed below the Horizon of the Glass, as it is elevated above; then take the perpendicular height of the Center of the Glass from the Floor, then the Proportion for finding that Point in the Meridian on the Floor from the Window will be thus;

As

As the ſine of the latitude of the Place,
Is to the perpendicular height of the Glaſs in Inches and Parts,
So is the coſine of the latitude of the place,
To the diſtance of the Point in Inches and Parts.

Which diſtance being found, and placed upon the Meridian-line on the Floor, from the Window, will be the Point deſired.

Thus having found a Point in the reflected reverſed Axis, it is not hard, by help of a horizontal-Dyal and that Point, to draw the reflected hour-lines on any Cieling or Wall, be it never ſo concave or convex.

To do which, firſt place the Center of the Horizontal Dyal you intend to make uſe of, in the Center of the Glaſs, the hour-lines of the ſaid Dyal being horizontal, and the Meridian of the ſaid Dyal in the Meridian of the World; which may be done by Plumb-lines let fall from the Meridian on the Cieling; then fix one end of a Thred or Silk in the Center of this Horizontal Dyal or Glaſs, and draw it directly over any hour-line of the Dyal which you intend to draw; and at the further ſide of the Room faſten that Thred with a ſmall Nail, ſo that the Thred may be horizontal, and over the Hours you intend to draw.

Then in the Point formerly found on the reverſed Axis, on the Floor, fix another Thred (as you did formerly) on the Center of the Dyal: then take that Thred, and make it juſt touch the Thred that was made faſt croſs the Room over the hour-line of the horizontal Dyal) in any Point thereof, it matters not whereabouts, and mark where the end of that Thread doth touch the Wall or Ceiling, and there make ſome Mark or Point.

Then again move the ſame Thred higher or lower at pleaſure, till it (as formerly) touch the ſame hour-Thred, and mark again whereabouts on the Wall or Ceiling the end of the ſaid Thred alſo toucheth: In like manner may be found more Points at pleaſure; but any two will be ſufficient for the drawing any hour-line on any Plane how irregular ſoever; for if you move a Thred directly between your Eye and the Points formerly found, you may project thereby as many Points as you pleaſe at every Angle of the Wall or Cieling, whereby the reflected hour-line may be exactly drawn.

Again, in like manner, remove the horizontal Thread that was faſtned in the Center of the horizontal Dyal, on any other hour-line deſired to be drawn, and as before, make it faſt at the further ſide of the Room, with a ſmall Nail, ſo that the Thread may be horizon-

tal; (as before) take the Thread fastened in the point in the reflected Axis, and bring it to touch the Thread of the hour-line in any part thereof, and mark where the end of that Thread doth touch the Wall or Cieling; then (as before) move the said Thread so, that it only touch the said Thread of the hour-line in any part thereof; and also mark where the end of that Thread doth touch the said Wall or Cieling, so is there found two points on the Wall or Cieling being in the reflected hour-line desired; by help of which two points, the whole hour-line may be drawn; for if (as before) a Thread be so situated, that it may interpose between the eye and the said two points found, you may make many points at pleasure; whereunto the said Thread may also interpose; which for more conveniency may be made at every angle or bending of the Wall or Cieling, be they never so many; so that if lines be drawn from point to point, that said reflected hour-line will be exactly drawn.

In like manner may the other hour-lines be drawn, so that the Reflex or spot of the Sun from the said horizontal Glass situated in the said Window (as before) shining among the said reflected hour-lines drawn on the Wall or Cieling, will exactly shew the hour of the day desired.

Now if lines be drawn round about the said Room equal to the Horizon of the said Glass, it will shew when the Sun is in or near the Horizon.

CHAP.

CHAP. XXIV.

How to draw the Equator, and Tropicks and other Circles of Declination, as also the Sign the Sun is in the Parallel of the length of the Day, and the like, on a Wall or Cieling to any Horizontal Reflecting Glass.

I. *To draw the Reflected Equator.*

THE Equator being a great Circle of the Sphear, it will become a straight line: therefore take the Thread fixed in the Center of the Glass, and move the end thereof to and fro in the Meridian-line drawn on the Cieling, until by help of a Quadrant, the said Thread be elevated equal to the Complement of the Latitude of the Place, which will always be perpendicular to the reversed Axis marked in the Meridian of the Cieling where the end of the Thread falls; then on that Point erect a Perpendicular to the Meridian of the Cieling, and that Line will be the Equator desired.

II. *To draw the Tropicks and the Entrance of the Sun into any of the Twelve Signs.*

Note, The Tropicks and other Circles of Declination are lesser Circles, and on all Dyals become Conick Sections.

Therefore first look in the Tables of the Altitude of the Sun, for a Table of Altitude for the latitude of the Place that you draw the Cieling Dyal for; and there you will have the Altitude of the Sun for each hour of the Day at the entrance of the Sun into the twelve Signs.

Then take the Thread fixed in the Center of the Glass, and by applying one side of a Quadrant to the said Thread, and moving one end of it to and fro in the hour-line proposed, till the Thread doth cut the edge of the Quadrant in the same degrees answerable to the Suns height in that hour when he is in that Tropick you desire to draw, and mark where the end of that Thread so elevated, toucheth

the Cieling in that hour-line propoſed; ſo may you in like manner find ſeveral Points in each hour-line for the Suns height in that Tropick, whereby a line may be drawn on the Wall or Cieling from Point to Point, formerly made in the ſaid hour-lines, which will be the Tropick deſired.

In like manner may any of the Parallels of the Signs be drawn, ſeeing you have in the ſame Table the Suns Altitude at his Entrance into any of them.

III. *To draw the Parallels of Declination, and Length of the Day.*

Having the Thread fixed to the Center of the Dyal, then note that the Equator is elevated above the Horizon ſo much as is the complement of the latitude of the Place, and the Parallels of Declination are accounted on both ſides thereof; therefore if you would draw any Parallel of Declination, you muſt firſt know whether it be North or South Declination; for the North Declination muſt be accounted above the Equator, and the South below; and the Account muſt begin at the Equator, and it never exceeds 23 degrees and 30 minutes, which is at both the Tropicks.

Now if you would draw the Parallel of 10 deg. North in the latitude of *London*, then add 10 deg. to the height of the Equator, which is 38 deg and 28 min. and their ſum will be 48 deg. and 28 min: then take the Thread that is made faſt to the Center of the Glaſs, and move it to and fro in any hour-line propos'd, till by the edge of the Quadrant you find the ſtring to cut 48 deg. and 28 min. and at that end of the String or Thread on the hour-line propoſed, make a mark: In the like manner may you find Points on every hour-line (ſtill letting the String or Thread cut the ſame degrees on the Quadrant) and lines being drawn from Point to Point. ſo that they make no Angles, this line ſo drawn, will be the parallel of 10 deg. of North declination. If you had been to have drawn the parallel of 10 deg. of South Declination, then you muſt ſubſtract 10 deg. from 38 deg. and 28 min. and there would remain 28 deg. and 28 min. and the Thread muſt always cut the ſame degrees on the Quadrant on every hour-line.

In like manner may you draw any other Parallel of Declination.

I have been the more large on this, becauſe I would make it eaſie: The drawing the Parallel of the length of the Day depends on the Suns Declination.

To

To draw the Parallel of the Length of the Day.

Before you can begin to draw these Parallels, you must know what Declination the Sun hath on those days whose length are in equal hours: The manner of finding the Declination on these Days, I have already shewed in the foregoing Chapters; yet it will be needful to insert the Table once more.

The manner of drawing these Parallels on a Cieling-Dyal, is the very same with the drawing of the Parallels of Declination, and therefore more Words will be needless.

Length of the Day.	Suns declination		
	d.	m.	
VS	23	30	
8	21	40	South.
9	16	55	
10	11	37	
11	5	55	
12	00	00	
13	5	50	North.
14	11	37	
15	16	55	
16	21	40	
8	23	30	

CHAP.

CHAP. XXV.

To draw the Azimuth-Lines on any Wall or Cieling to any Horizontal Reflecting Glass.

THese are great Circles of the Sphear, and therefore they will be right Lines on the Dyal.

First you must find a vertical Point, either above to the Zenith, or below to the Nadir of the Glass (which is no more than a Perpendicular or Plumb-line) and mark in what Point it cuts the Floor of the Room, which Point is called the Reflected Vertical Point; in which Point must be the end of a Thread fixed; for by a Point found in the reflected Axis of the Horizon, the Azimuths may be drawn, as by a Point found in the reflected Axis of the Equator, the Hour-lines may be drawn.

Then on a Pasteboard or other Material, draw the Points of the Compass, or other degrees, and fix the Center thereof in the Center of the Glass, and the Meridian thereof in the Meridian of the World; but you must be sure to place it horizontal; then take the Thread fixed in the place of the Glass, and draw it over any Azimuth which is desired to be drawn, and at the further side of the Room make that Thread fast, as you did when you were drawing the reflecting hour-lines; then take the Thread, whose end is fastened in the said reflected vertical Point, and bring that Thread so as just to touch the said horizontal Thread, and augment it until the end thereof touch the Wall or Cieling, and there make a mark or point: In like manner move the said Thread whose end is fastned in the said vertical Point, higher or lower at pleasure, till as formerly, it touch the said horizontal Thread; and mark again where soever the end thereof toucheth the Wall or Cieling. Now by the help of these two Points found in the reflected Azimuth-line, the whole Azimuth-line may be drawn; for if (as before in drawing the hour-line) a Thread be so situated, that it may interpose between the Eye and the said two Points, you may make many Points at pleasure, to which the said Thread so situated may also interpose; which may be made at every angle or bending of the Wall or Cieling (as before) whereby the reflected Azimuth-line desired may be drawn; in like manner may the other reflected Azimuth-lines be drawn.

Also

Also there may be lines drawn parallel to the horizon round about the Room, by help of the Thread fixed in the Center of the Glass, and a Quadrant for the elevation thereof, which will shew the Sun's Altitude at any Appearance thereof.

Thus have I shewed the drawing of a reflected Dyal from an horizontal Glass, with all the usual Furniture thereon, though the Wall or Cieling be never so gibbous or irregular, or what shape soever.

Now the Glass may be exactly situated horizontal, if you draw a reflected Parallel for the present Day, and know also the true hour, and so place the Glass, that the Spot of the Sun may fall thereon, on the Cieling or Wall; for there is no way by an Instrument to do it, the Glass is so small; if the Glass be fixed in a Bowl-locket, it will be best, otherwise it may be placed in Putty in the hole of the Transom.

The manner of drawing the *Italian* and *Babyloniſh* with the *Jewiſh*, or old unequal hours, are the same as in an horizontal Dyal; therefore it will be needless for me to repeat those things over again.

The manner of drawing of the Hour-lines on a Cieling, to any reclining reflecting Glasses, is as followeth, according to the Directions of *John Lyon*, Publiſhed by Mr. *Collins*, in the Year 1658.

Of Reclining Reflecting Glaſſes.

Reflected Dyalling from any Reclining Glaſs.

I ſhall now ſhew how to draw any Reflected Dyal with all the Furniture (that poſſible may be) the Glaſs being ſet at any poſſible Reclination.

In the drawing of which, there is principally to be conſidered,

1. *The Reflected Horizon.*
2. *The Reflected Meridian.*

Note, The Horizon and Meridian are two great Circles.

CHAP. XXIII

I. *To draw the Reflected Horizon according to the Situation of any Reclining Glaſs whatſoever.*

FIrſt, Let two pieces of nealed Wire be faſtned on the Window on each ſide of the ſaid Glaſs, the Ends thereof being without the Room in the Air, at whoſe ends let there be faſtned a Thread, which may be pulled ſtraight at pleaſure, by bending of the Wire; then bend thoſe Wires upward or downward, until the Thread faſtned at the end of each Wire be exactly horizontal with the Center of the Glaſs, which may be tried by a Quadrant; then tie a ſtring or thread croſs the room, in ſuch ſort that I may from moſt part of the thread ſee the reflecting Glaſs, and therein the ſaid horizontal thread without the room: then on the ſaid thread croſs the room, tie a ſlipping knot to move to and fro at pleaſure, which knot move to and fro on the ſaid thread, until by looking in the ſaid Glaſs I find from my Eye the ſaid knot and part of the horizontal thread without, all as it were in a right line, the one interpoſing the ſight of the other. Then being careful to keep the knot in that poſition, faſten one end of a thread in the place of the Center of the reclining reflecting Glaſs, and bring that thread

thread ſo, as juſt to touch the aforeſaid knot, augmenting that thread, until the end thereof touch the Wall or Cieling, and there make a mark or point, ſo is there one point found on the Wall or Cieling in the reflected horizon of the world. Then begin again, and remove the poſition of that thread which went overthwart the room, either higher or lower at pleaſure, ſtill having regard that you may from the moſt part of the ſaid thread ſee the reflecting Glaſs, and therein the ſame horizontal thread without the room. Then, as before, move the ſaid knot on the ſaid thread to and fro, until (as before) by looking in the ſaid Glaſs, you find from your Eye the ſaid knot, and part of the horizontal thread both in one right line, the one interpoſing the ſight of the other; and by the ſaid knot bring that thread whoſe end is faſtned in the Center of the ſaid Glaſs, and keeping it juſt to touch the ſaid knot, continue it, until the end thereof touch the Wall or Cieling, as before, and there make another mark or point; ſo is there two points found in the ſaid reflected horizon on the Wall or Cieling: By which ſaid two points, if a thread (as before) be ſo ſituated, that it may interpoſe between the eye and the ſaid two points, there may be many points made to be in the ſame interpoſition of the thread, which, as before, may be made at every bending or angle of the Wall or Cieling, whereby the reflected Horizon deſired may be drawn, by drawing a line from point to point round about the Room; which will be the true reflected Horizon according to the ſituation of the Glaſs.

LI CHAP.

CHAP. XXVII.

II. *To draw the Reflected Meridian according to the ſituation of any Reclining Glaſs whatſoever.*

FIrſt, Take a Lath, or thin piece of wood of any convenient length at pleaſure, as ſome one and a half, or two foot long, and at each end thereof make a hole, the one to hang a Thread and Plummet, and the other is to put a ſmall Nail therein, to faſten it in ſome part of the window over the Center of the Glaſs, ſo that the Thread and Plummet may hang without the Room; then by help of the Suns Azimuth, you may draw the Meridian-line, as before, as if the Glaſs were horizontal, and move the Lath with the Thread and Plummet at the end of it to and fro, until the Thread and Plummet be in the direct Meridian of the world with the center of the Glaſs. Then, as before, tie a Thread croſs the room, in ſuch ſort, that from or by ſome part of the ſaid Thread both the reclining Glaſs and the Thread to which the Plummet is faſtned, may be ſeen at one time. Then, as before, on the ſaid Thread which croſſes the room, tie a ſlipping knot, which move to and fro on the ſaid ſtring, until by looking in the ſaid Glaſs you find from your Eye the ſaid knot and ſome part of the perpendicular Thread without, all as it were in one right line, the one ſhadowing or interpoſing the ſight of the other, being then very careful to keep that knot in the ſame poſition; then take the Thread (the end thereof being faſtned in the ſaid Center of the Glaſs) and bringing it juſt to touch the ſaid knot, augment that Thread, until the end thereof touch the ſaid Wall or Cieling, and the ſaid Thread alſo touch the knot, as before; then in that place where the end of the ſaid Thread toucheth the Wall or Cieling, make a mark, which mark or point will be directly in the reflected Meridian of the world, according to the ſituation of that Glaſs. Then again remove that thread (overthwart the room) on which the ſaid knot is, either higher or lower than it formerly was, at pleaſure, ſtill having regard that from ſome part of the ſaid thread within you may ſee both the reclining glaſs and the perpendicular Thread without at one time; and, as before, move the ſaid knot on the ſaid Thread, until by looking in the ſaid reclining Glaſs, you ſee the ſaid knot and ſome part of the perpendicular thread without in one right line, ſo as the one ſha-

dows

dows or hinders the ſight of the other, as before, which knot then muſt not be removed from its ſituation; then take that Thread, whoſe end is faſtned in the Glaſs, and bring it to touch that knot, the end of the ſaid Thread being continued to touch the Wall or Cieling; ſo is that point of touch on the Cieling another point found in the reflected Meridian of the World: ſo is there 2 points found in the ſaid reflected Meridian on the Wall or Cieling; by which, if a Thread, as before, be ſo ſituated, that it may interpoſe between the Eye and the ſaid two points, many points thereby in the ſaid reflected Meridian may be made at every bending or angle of the Wall or Cieling, whereby the reflected Meridian deſired may be drawn, by drawing a line from point to point obliquely in the Room, which will be the true reflected Meridian of the World, according to the ſituation of that Glaſs.

Now this reflected Horizon and Meridian being firſt drawn, they will be of great uſe in drawing the Hour-lines, together with all the Furniture that poſſibly can be drawn on any Dyal.

CHAP. XXVIII.

To draw the Reflected Hour-lines to any Reclining Glass on any Plane whatsoever, that the Sun will be reflected on, by help of an ordinary Horizontal Dyal for that Latitude.

FIrst, extend several threads from the center of the Glass to the extremity of the reflected horizon in the Room (which for more conveniency and use may be the several hour-lines, and may also serve as a bed to situate the horizontal Dyal on the reflected Horizon) having regard to situate the center of the Dyal on the center of the Glass, and the Meridian of that Dyal on the reflected Meridian of the World: Then to find the point in the reflected reversed Axis on the floor of the room; Take a thread, one end thereof being fastned in the center of the Glass, and move the other end thereof to and fro in the reflected meridian under the reflected Horizon, until by help of a Quadrant the said thread is found to be depressed under the reflected Horizon, equal to the latitude of the place, and where the end of the said thread intersects or meets the reflected meridian either on the floor or wall, that point is the reflected reversed Axis, as was required. In which point fasten one end of a thread, which thread will be of great use in drawing the reflected hour-lines on any wall or cieling whatsoever. Now if this thread, whose end is fastned in a point on the reflected reversed Axis, be taken and brought to touch any part of any one of the threads of the hour-lines (produced to, and fastned in the reflected Horizon) the said thread being continued so, as that the end thereof may touch the wall or cieling, and also any part of the said thread touch the hour-line or thread proposed, that point on the wall or cieling is in the reflected hour-line desired to be drawn: Also the other point in the same reflected hour-line may be found, if the said thread, whose end is fastned in the reflected Axis, be brought to touch some other part of the same hour-thread proposed; so that when (as before) the end of the said thread toucheth the wall or cieling, some part of that thread may also touch the hour-line desired, which point of touch on the wall or cieling, is also another point in the said reflected hour-line desired. By which

which two points so found (as before) the reflected hour-line may be drawn by a thread, projecting by those points from the eye as it was formerly directed in drawing the reflected hour-lines to an horizontal Glass.

CHAP. XXIX.

To draw the reflected Equinoctial Line, and also the Tropicks on any Wall or Cieling, to any reclining reflecting Glass.

1. To draw the reflected Equinoctial Line on the Wall or Cieling.

TAke that thread, whose end is fastned in the Center of the reclining Glass, and move the other end thereof to and fro in the said reflected Meridian formerly drawn, until (by help of a Quadrant) the said thread is elevated above the reflected Horizon formerly drawn, equal to the Complement of the Latitude (which as before, will always be perpendicular to the reversed Axis) and make a point in the said Meridian, where the end of the said thread toucheth; then on that point and the said reflected Meridian on the Cieling, raise a perpendicular Line, which is the reflected Equinoctial Line desired.

CHAP.

CHAP. XXX.

II. *To draw the Reflected Tropicks, or other Parallels of Declination.*

FIrſt (as before) make or take out of ſome Book a Table of the Suns Altitude for each hour of the Day, calculated for the Place or Latitude propoſed, when the Sun is in either of the Tropicks, or other parallel of declination; then take that thread whoſe end is faſtned in the Center of the Glaſs, move the other end thereof to and fro in the hour-line propoſed, until by applying one ſide of a Quadrant to the ſaid thread, you find the ſaid thread elevated above the reflected Horizon, anſwerable to the Suns height in the hour propoſed, when he is in that Tropick or Degree of Declination propoſed. Which Altitude required will be found in the aforeſaid Table for that end calculated; the ſaid thread being of the elevation above the reflected Horizon, as the ſaid Table directeth; then mark where the end of the thread (ſo elevated) toucheth the Wall or Cieling in that hour-line; ſo is one Point found in the reflected Parallel of Declination deſired to be drawn. In like manner, find in the ſaid Table in the ſaid Parallel of Degree of Declination, what Altitude the Sun hath at the next hour, and elevate the ſaid thread, whoſe end is faſtned in the Center of the Glaſs, equal to the Suns Altitude in that hour above the ſaid reflected Horizon, by help of the ſaid Quadrant, and where the other end of the ſaid thread falleth in the hour-line propoſed, make another Mark or Point. And ſo in like manner, make the Points (belonging to that Parallel of Declination) in the remaining hour-lines, according to the ſeveral Altitudes found in the ſaid Table of Altitudes: Then draw by hand a line to paſs through thoſe ſeveral Points ſo found, as before, which line is the reflected Parallel of the Suns Declination deſired. In like manner may be drawn all or any other Parallel of Declination, which may have reſpect to the Suns place, or the length of the Day, as ſhall be deſired.

CHAP. XXXI.

To draw the said reflected Tropicks, or other Parallels of Declination without any Tables calculated, only, by help of a Trigon *first made on Pastebord or other Material.*

Note, *That all Parallels are lesser Circles.*

FIrst (as formerly is shewed in drawing the Parallels of Declination to a reflecting Horizontal Glass) fasten the Trigon on the reflected reversed Axis, so that the Center of the Trigon may be in the Center of the Glass, then also will the Equinoctial on the Trigon be perpendicular to the said reflected reversed Axis: Then take the thread fixed in the Center of the said Glass, (which is also in the Center of the Trigon) and lay it upon that Parallel of Declination drawn on the said Trigon, whose reflected Parallel is required to be drawn on the Plane or Cieling; then move the Trigon, the thred lying on the said Parallel, until the end of the said thread touch any hour-line on the said Wall or Cieling; on which point of touch on that hour-line, make a mark, so will that point be in the reflected Parallel of Declination desired. In like manner, move the said Trigon, still keeping the thread on the same Parallel, until the end of that thread touch another hour-line on the said Plane or Cieling, and there also make another mark. And so in like manner find a point in each hour-line through which that reflected Parallel must pass; then drawing a line to pass through those several points on the said Plane or Cieling, that line is the reflected Parallel of the Suns Declination desired.

In like manner may be drawn any other reflected Parallel of Declination required.

CHAP.

CHAP. XXXII.

To draw the reflected Azimuth-lines to any reclining Glass on any Plane whatsoever that the Sun-beams will be reflected on.

Here note, *That Azimuths are great Circles.*

FIrst, Know that the reflected vertical Point in the Axis of the reflected Horizon, will always be found in the reflected Meridian. And look how many degrees the reflected Horizon differs from the direct Horizon, so many must the reflected Axis of the Horizon differ from the direct Axis of the Horizon: Hence the reflected vertical Point, whereby the reflected Azimuth-lines are drawn, may be thus found;

Take that thread whose end is fixed in the Center of the Glass, and move the other end thereof to and fro in the reflected Meridian, until by applying one side of a Quadrant thereto, you find the said thread depressed just 90 degrees, or perpendicular under the reflected Horizon; then make a mark or point where the other end of the said thread toucheth the said reflected Meridian on the Wall, Ground, or Floor of the Room, which point so found, is the reflected vertical point desired, in which point fasten one end of a thread.

Then on Pastebord or other Material draw the points of the Compass or other degrees, placing the Center thereof in the Center of the Glass, and the Meridian thereof in the reflected Meridian of the World, which said Pastebord must be also situated in the reflected Horizon just as the horizontal Dyal was formerly directed to be for drawing the reflected hour-lines: And as the threads from the Center fastned in the reflected Horizon, were also the hour-lines on the horizontal Dyal, whereby the reflected hour-lines were drawn; so now the threads from the Center fastned in the reflected Horizon may be the horizontal Azimuth-lines, whereby the reflected Azimuth-lines may be drawn: Or, if that thread which is fastned in the Center of the Glass, be drawn exactly over any Azimuth-line, the end whereof being fastned by a Nail, or other means in the reflected Horizon on the other side

of

of the Room, there may ſeveral Points be found in the Wall or Cieling, through which the reflected Azimuth-line muſt paſs, as followeth:

Take that thread, one end of which is faſtned in the ſaid vertical Point, and bring it juſt to touch the Azimuth-thread formerly faſtned, and continue it until the end thereof touch the Wall or Cieling, and alſo the thread it ſelf touch the ſaid Azimuth it ſelf, as before; in which point of touch on the Wall or Cieling, make a mark, through which point that reflected Azimuth-line muſt paſs: Then move the ſaid ſtring faſtned in the ſaid vertical point, ſo that it may juſt touch the ſaid thread again, but in another place; then, as before, continue that thread, until the end thereof touch the Wall or Cieling again, as before; and there make another mark, through which the ſaid reflected Azimuth-line muſt alſo paſs: In like manner may more points be found for your further Guide, in drawing that Azimuth-line: But two points being found will be ſufficient.

CHAP. XXXIII.

To draw any reflected Line by any two Points given over any Plane whatſoever, without projecting by the Eye.

FAſten two threads in the place of the Center of the ſaid reclining Glaſs, drawing the ſaid threads ſtraight, faſtning each of the other ends in the two reflected Azimuth-points formerly found on the Wall or Cieling. Then ſituate a thread croſs or thwart the room, ſo as it may croſs thoſe other threads from the Center, near at right Angles, and alſo juſt touch both of them in that ſituation: By which ſaid thread croſs the room may any number of points in the ſaid reflected Azimuth line to be drawn, be found at pleaſure; for if the end of another thread be alſo faſtned in the Center of the ſaid Glaſs, making the other end thereof to touch the Wall or Cieling, but ſo that it may alſo juſt touch the ſaid thread, which is faſtned croſs the room, which point of touch on the ſaid Wall or Cieling is another point in the ſaid reflected Azimuth-line required to be drawn.

In like manner may more points be found at every angle or bending of the Wall or Cieling for the exacter drawing the reflected Azimuth-line required, which doth find points, whereby is drawn the ſame reflected Azimuth line (or other lines) as was formerly done by a thread ſo ſituated, that it may interpoſe between the eye and any two points aſſigned on the Wall or Cieling.

In like manner, if the thread faſtned on the further ſide of the room, were removed on another Azimuth-line on the ſaid Paſtebord, and then faſten it again on the further ſide of the room (as before) you may by help of the ſaid thread faſtned in the ſaid vertical point, find ſeveral points on the Wall or Cieling, through which that Azimuth-line will paſs: So may you either by this or the former way draw what Azimuth-lines you pleaſe, either in Points of the Mariners Compaſs or Degrees, as you pleaſe, by drawing it firſt on Paſtebord, as before is directed.

And note generally, that ſuch Relation the Point found on the Floor or Ground in the reflected reverſed Axis, hath to the hour-lines drawn on the horizontal Dyal, in drawing the reflected hour-lines, the ſame hath the reflected vertical Point found on the Floor or Ground, to the Azimuths drawn on the Paſtebord in drawing the reflected Azimuth-lines.

CHAP.

CHAP. XXXIV.

To draw the reflected Parallels of the Suns Altitude, or Proportions of Shadows to any reclining Glaſs on any Plane whatſoever that the Sun-Beams will be reflected on.

Here note, That Parallels of Altitude are leſſer Circles, therefore are not repreſented by a right Line.

Firſt, Know generally, that what reſpect the Parallels of Declination have to the hour-lines, ſuch have the Parallels of the Altitude to the Azimuths.

For if one end of a thread be faſtned in the place of the Center of the reclining Glaſs, and the other end moved to and fro in any reflected Azimuth-line, until the ſaid thread be elevated any number of degrees propoſed above the reflected Horizon, the Elevation of which thread being found, by applying a Quadrant thereto, and making a Mark or Point where the end of the ſaid thread toucheth the ſaid reflected Azimuth drawn on the Wall or Cieling, that Point ſo found is the Point through which that Almicanter or reflected Parallel of the Suns Altitude muſt paſs.

In like manner, remove the other end of the ſaid thread faſtned in the Center of the Glaſs, to another reflected Azimuth-line, and (as before) move it higher or lower, until by applying the edge of a Quadrant to that thread, you find the ſaid thread above the reflected Horizon the ſame number of degrees firſt propoſed, and at the end of the ſaid thread in that reflected Azimuth-line drawn on the Wall or Cieling, make another Mark or Point, through which the ſame reflected Almicanter or Parallel of Altitude muſt alſo paſs: And ſo in like manner you will find a Point on each reflected Azimuth-line, through which the ſame Parallel of Altitude muſt paſs: Then drawing by hand a line to paſs through theſe ſeveral Points ſo found, as before, that line is the reflected Parallel of the Suns Altitude propoſed. In like manner may be drawn all the other Parallels of Altitude deſired, which will ſhew the Suns Altitude, or the proportion of any Shadow to its Altitude, at any appearance of the Suns Reflex thereon.

CHAP. XXXV.

To draw the Jewish *or old unequal Hour-lines to any Reclining Glass on any Plane whatsoever that the Sun-Beams will be reflected on.*

Here note, That the Jewish *Hour-lines are great Circles.*

FIrst (by the Rules formerly given) draw two reflected Parallels of Declination of 16 deg. 55 min. the one being near the Summer, and the other near the Winter Tropick: for when the Sun hath that Declination, the Day is 15 hours long in the Summer, and 9 in the Winter: Then (as is formerly directed) situate a Thread just between the Eye, and those three Points in the said reflected Dyal, as is expressed in the ensuing Table; so may you thereby draw all or any of those *Jewish* hour-lines desired, which will at any appearance of the Spot by the Reflex of the Glass amongst those hour-lines, shew how many of the equal hours is past since Sun-rising, as was desired. Now in this Latitude of 51 deg. 30 min. if the Parallels of the Suns Declination be drawn, both when the Day is 9 and 15 hours long, that is, when it is 16 deg. 55 min. any of these *Jewish* hour-lines will intersect the common hour-lines, either upon the hours, half hours, or Quarters. And such a Declination may be found, that it shall so do in any Latitude desired.

Uneq. hours.	15 H. M.	*Equal hours.*	9 H. M.	*Uneq. hours.*	15 H. M.	*Equal hours.*	9 H. M.
0	4 30	6	7 30				
1	5 45	7	8 15	7	1 15	1	0 45
2	7 00	8	9 00	8	2 30	2	1 30
3	8 15	9	9 45	9	3 45	3	2 15
4	9 30	10	10 30	10	5 00	4	3 00
5	10 45	11	11 15	11	6 15	5	3 45
6	12 00	12	12 00	12	7 30	6	4 30

CHAP. XXXVI.

To draw the Circles of Position to any Reclining Glass on any Plane whatsoever that the Sun-Beams will be reflected on.

NOte, That all Circles of Position are great Circles of the Sphear, and do alwavs intersect each other in that Point of the Reflected Meridian which toucheth the reflected Horizon, which may be called the common intersection; which said Circles of Position are reckoned upon the reflected Equinoctial both ways from the said Meridian down to the said Horizon; the Horizon Eastward being the Cuspis of the first House, and the Horizon Westward being the Cuspis of the seventh House, and the reflected Meridian the Cuspis of the tenth House: So that those Meridian-Planes, whose Reclination is 60 deg. Westward, (being measured from the Meridian in the Equinoctial) lies in the Cuspis of the eighth House, and 30 deg. Westward lies in the Cuspis of the ninth House, and 30 deg. Eastward in the Cuspis of the eleventh House, and 60 deg. Eastward in the Cuspis of the twelfth House; which are all the Houses above the Horizon.

CHAP.

CHAP. XXXVII.

How to draw any Circle of Poſition, or the Cuſpis of any Houſe on any Cieling or Wall to any Reclining Glaſs.

FIrſt, Faſten a Thread in ſuch ſort, within the Room, as that it may interpoſe between the Eye and the common Point of interſection on the Wall or Cieling, and alſo between that point where the reflected hour-line of 4 (being 60 deg. Weſtward from the ſaid Meridian) interſects the reflected Equinoctial alſo on the Cieling, whereby Points may be made at every bending or Angle of the Wall or Cieling, to which the thread ſo ſituated may alſo interpoſe, by which Points the reflected Cuſpis of the eighth Houſe may be drawn. In like manner may the Cuſpis of any other Houſe above the horizon, as the 9th. or 10th. which is the Meridian (or *Medium Cœli*) or 11th. or 12th. be drawn alſo. For if (as before) the ſaid thread be again ſo faſtned within the Room, as that it may alſo interpoſe between the Eye and the ſaid common Point of interſection, and alſo thoſe Points where the reflected hour-line of 2 (being 30 deg. Weſtward from the Meridian) do cut the reflected Equinoctial, whereby may be drawn the reflected Cuſpis of the ninth Houſe; or where the reflected hour-line of 10 (being alſo 30 deg. Eaſtward from the Meridian) doth alſo cut the ſaid reflected Equinoctial, whereby may be drawn the Cuſpis of the 11th. Houſe: or where the reflected hour-line of 8 (being 60 deg. Eaſtward from the Meridian) do alſo cut the ſaid reflected Equinoctial, whereby may be drawn the Cuſpis of the 12th. Houſe. The Horizon always being the Cuſpis of the firſt and ſeventh Houſes, and the Meridian the Cuſpis of the 10th. Houſe or *Medium Cœli*; wherein generally it is to be noted, That in all Planes which cut the common interſection of the Meridian and Horizon (as doth the Horizontal, and alſo all Meridian Planes both direct and reclining) theſe Circles of Poſition are all parallel to the Meridian, and therefore parallel each to other. For look what reſpect the hour-lines in all direct or reclining polar Planes, or direct Meridian Planes have to the Axis of the World, ſuch reſpect have the Circles of Poſition in all horizontal, or direct Meridian, or reclining Meridian Planes, to the Axis of the Prime vertical; for as the hour-lines in the firſt

are

are all parallel to the Axis of the Equinoctial, in whose Poles they meet; so the Circles of Position in the second are all parallel to the Axis of the Prime Vertical, in whose Poles they also meet.

The Reason why Glasses reflect a double Spot, is because they are polish'd on both sides, which may be remedied with a Pumex-Stone,

Those that desire to read more of this Subject, may see what is written by Kircher in Primitiis Gnomicæ Catoptricæ, *and since him by* Magnan, *and others.*

CHAP.

DIRECT DYALLING
By a Hole or Nodus.

CHAP. XXXVIII

To draw a Dyal under any Window that the Sun ſhines upon by help of a Thread faſtned in any Point of the direct Axis found in the Cieling, and a Hole in any Pane of Glaſs, or a Knob or Nodus upon any ſide of the Window or Window-Poſt.

FIrſt, Draw on Paſtebord or other Material, an horizontal Dyal for the Latitude propoſed.

Then by help of the Suns Azimuth, which may be found by help of a general Quadrant, at any time, or by knowing the true hour of the Day with the help of the ſaid Horizontal Dyal; and draw that true Meridian from the Hole or Nodus propoſed, both above on the Cieling, and below on the Walls and Floor of the Room; ſo that if a right Line were extended from the ſaid Hole or Nodus by any Point in any of thoſe Lines, it would be in the Meridian Circle of the World.

CHAP.

CHAP. XXXIX.

To find a Point in the direct Axis of the World, which will ever fall to be in the ſaid Meridian, in which Point the end of a Thread is to be faſtned.

FIrſt, Fix the end of a Thread or ſmall Silk in the Center of the Hole or Nodus, and move the other end thereof up or down in the ſaid Meridian formerly drawn on the Cieling or Wall, until by applying the ſide of a Quadrant to that Thread, it is found to be elevated equal to the Latitude of the Place; ſo is that Thread directly ſituated parallel to the Axis of the World, and the Point where the end of that Thread toucheth the Meridian either on the Cieling or Wall, is that Point in the direct Axis ſought for; wherein fix one end of a Thread (which Thread will be of preſent uſe in projecting of hour-points in any place propoſed.

CHAP. XL.

How to find the Hour-Points either under the Window, or any other convenient Place in the Room.

PLace the Center of the ſaid horizontal Dyal in the Center of the Hole or Nodus; alſo ſituate the ſaid Dyal exactly parallel to the Horizon, and the Meridian of the ſaid Dyal in the Meridian of the World, which (as before) may eaſily be done, if at that inſtant you know the true hour of the Day.

Then take the Thread whoſe end is fixed in a Point in the direct Axis, and move it to and fro, until the ſaid Thread doth interpoſe between your Eye and the hour-line on the ſaid horizontal Dyal which you intend to draw, and then keeping your Eye at that ſituation, make a Point or Mark in any place where you pleaſe, or under the Window, ſo that the ſaid Thread or String may interpoſe between that Point or Mark ſo made, and your Eye, as aforeſaid; which ſaid Point ſo found, will ſhew the true time of the Day at that hour all the year long, the Sun ſhining thereon; ſo will that Point, together with the ſaid Thread, ſerve to ſhew the hour, inſtead of an hour-line.

In like manner, the ſaid Thread fixed in the Axis, may be moved to and fro, until the ſaid Thread doth interpoſe between the Eye and any other hour-line deſired on the ſaid horizontal Dyal; and then, (as before) make another Point or Mark in any place at pleaſure, or under the ſaid Window, by projecting a Point from the Eye, ſo that the ſaid Thread alſo interpoſe between that Point to be made, and the Eye; ſo will that Point ſo found, ſhew the true time of the Day for the ſame hour that did the hour-line on the ſaid horizontal Dyal, which was ſhadowed by the ſaid Thread.

In like manner may you proceed (by help of that Thread, and the ſeveral hour-lines on the ſaid horizontal Dyal) to find the other hour-points, which muſt have the ſame Numbers ſet to them, as have the hour-lines on the ſaid horizontal Dyal.

Otherwiſe to make a Dyal from a Hole in any Pane of Glaſs in a Window, and to graduate the hour-lines below on the Sell or Beam, or on the Ground, that Hole is ſuppoſed to be the Center of the horizontal Dyal, and being true placed, the Style thereof, if ſuppoſed continued,

tinued, will run into the Point in the Meridian of the Cieling before found, where a Thread is to be fixed: then let one extend a Thread faſtned in the Center of the horizontal Dyal parallel to the Horizon, over each reſpective hour-line, and holding it ſteady, let another extend the Thread faſtned in the Meridian, in the Cieling along by the edges of the former horizontal Thread, and ſo this latter Thread will find divers Points on the ground, through which, if hour-lines be drawn, and the Sun ſhine through the Hole in the Pane of Glaſs before made, the Spot of the Sun on the Ground ſhall ſhew the time of the Day.

For the Points that will be thus found on the Beam or Tranſom, the Thread fixed in the Cieling, or inſtead of it a piece of Tape there fixed, muſt be moved ſo up and down, that the ſpot of the Sun may ſhine upon it, and being extended to the Tranſom or Beam graduated with the hour-lines, as before directed, it there ſhews the time of the Day. Here note, that it will be convenient to have that Pane of Glaſs darkned through which that Spot is to ſhine.

In like manner may a Dyal be made from a Nail head, a knot in a ſtring tied any where acroſs, or from any Point driven into the Bar of a Window, and the hour-lines graduated upon the Tranſom or Board underneath.

CHAP. XLI.

Of Refracted Dyals.

IF you ſtick up a Pin or Stick, or aſſign any Point in any concave Bowl or Diſh, to ſhew the hour, and make that the Center of the horizontal Dyal, aſſigning the Meridian-line on the edges of the Bowl, point out the reſt of the hour-lines alſo on the edges of the Bowl, and taking away the horizontal Dyal, elevate a String or Thread from the end of the ſaid Pin faſtned thereto over the Meridian-line, equal to the Elevation of the Pole, or the Latitude of the Place; then with a Candle, or if you bring the Thread to ſhade upon any hour-point formerly marked out on the edges of the Bowl, at the ſame time the ſhade in the Bowl is the hour-line.

And if the Bowl be full of Water, or any other Liquor, you may draw the hour-lines, which will never ſhew the true hour, unleſs filled with the ſaid Liquor again.

CHAP. XLII.

How to draw the Parallels of the Signs or Declination, or Parallels of the Length of the Day, or any other Parallel that doth depend upon the Declination of the Sun, without having reſpect to the Hour-lines, and that three ſeveral ways Geometrically, which Ways never have been Publiſhed in any Language.

FIrſt, having the Subſtyle, and Style, and Nodus thereof given, as in Fig. A, from N, the Nodus of the Style, let fall a Perpendicular to the Style C N, *viz.* N G; then from the Point G in the Subſtyle, draw the Equator perpendicular to the Subſtyle C F V G R V E; then let N G be the Radius of a Circle, and deſcribe the Arch K G V; upon which Arch place the declination of the Parallel, which let be here 23 *d.* 30 *m.* both ways from G towards K and V; then from the Nodus N draw N V and N V, which two Points V and V in the Subſtyle will be the Parellels of ♋ and ♑; then draw a line from V through N towards T, and make N T equal to N and the neareſt V; and then divide T V into two equal parts in H, and divide V V into two equal parts in R; then make R F, R F equal to V H, and then will F F be equal to V T; this being done, open your Compaſſes to any convenient diſtance, and place one foot of them in the lower Point F; and with the other deſcribe a dark Arch (as are the Arches E E in the Fig. A) then the ſame diſtance place from V towards D, and open your Compaſſes from that Point to the upper V; the ſame diſtance of the Compaſſes being kept, and placing one foot in the upper F, and croſs the former Arches in P P, ſo may you do on both ſides of both the upper V and the lower V, and the upper F and the lower F, and from theſe interſections draw Lines ſo that they make no Angles, and the Line ſo drawn ſhall be the Parallel of ♋ and ♑; and ſo may you do for any other Parallel that you have a mind to draw.

CHAP.

The Second Way, Fig. B.

You muſt proceed in the former way till you have found V V and F F, and V T, and H and R; then by V and V draw Lines parallel to the Equator, as are the Lines B D and B D in the Fig. B; then make R L equal to R L on both ſides, and draw R L and R L quite through, which Lines may be called the Aſymptotes: Theſe being done, then a Ruler over V and any Point in one of the Aſymptotes, will alſo cut the other Aſymptotes in another Point (*viz.* as a Ruler over V, and the lower P in one Aſymptote, will cut the other Aſymptote in upper E; then if you take V E, and place it from P towards V, and there make a Mark or Point, and ſo take all the diſtence from V to E, and place them from P towards V; by which means you may have as many Points as you pleaſe; through which Points draw Lines ſo that they make no Angles, and that Line ſo drawn will be the Parallel deſired: So may you do for any other Parallel deſired.

But note, you muſt be ſure to take that V E that doth belong to P V, that is, when the Ruler lies over V, and any Point in that Aſymptote that is moſt remote from the Center V, at the ſame time the Ruler will cut the other Aſymptote in E. Now that diſtance from V to that E, muſt be placed from the other Aſymptote by the Ruler, and that will be the Point found.

The Third Way, Fig. D.

Having proceeded to find V V, and F F, and G, and H, and R, as you did in the two former ways, as alſo N T, then take the neareſt diſtance from N to the Subſtyle, which will be N P, and place it on the Style from N to W, and by W draw a Parallel to N G, and encreaſe N V till it meets that Parallel in X; then by the lower F draw a Parallel to the Equator, which will be F Y, and make F Y equal to W X; then draw a Line from the other F to X, and divide the angle F Y F into equal parts by the Line F G, then draw as many Parallels as you pleaſe to Y F (which will alſo be parallel to the Equator) till they cut the Line Y G; then take the diſtance of each Parallel from the Subſtyle, as in Fig. D. is O P, O P, O P; and ſetting one foot of your Compaſſes in F, croſs each Parallel, which will be in E E E, in the Fig. D. from each interſection of theſe Parallel Lines, ſo that they make no Angle, the Line ſo drawn will be the Parallel deſired; and ſo may you do for any other Parallel of Declination whatſoever.

Note

Note that these three Ways do respect those Dyals that have Centers; if the Axis of the World do not cut the Plain in any Angle, then the former Rules will be best.

These three Ways I had given me by my very Loving Friend Mr. *Edmond Halley* of *Queens-Colledge* in *Oxford*.

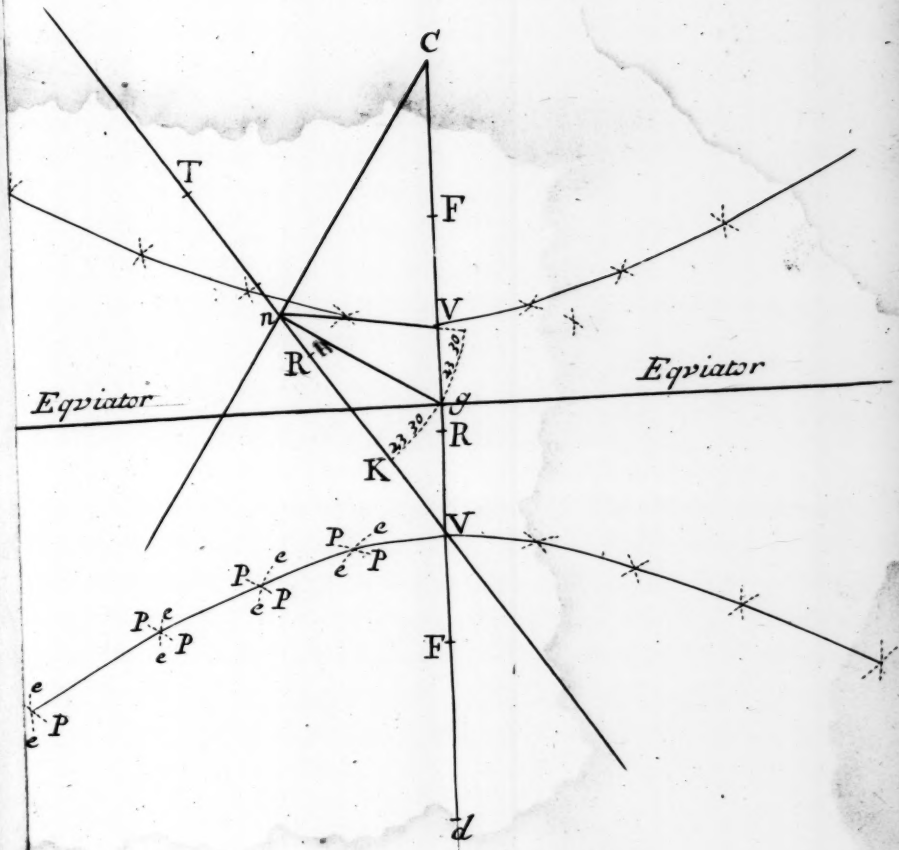
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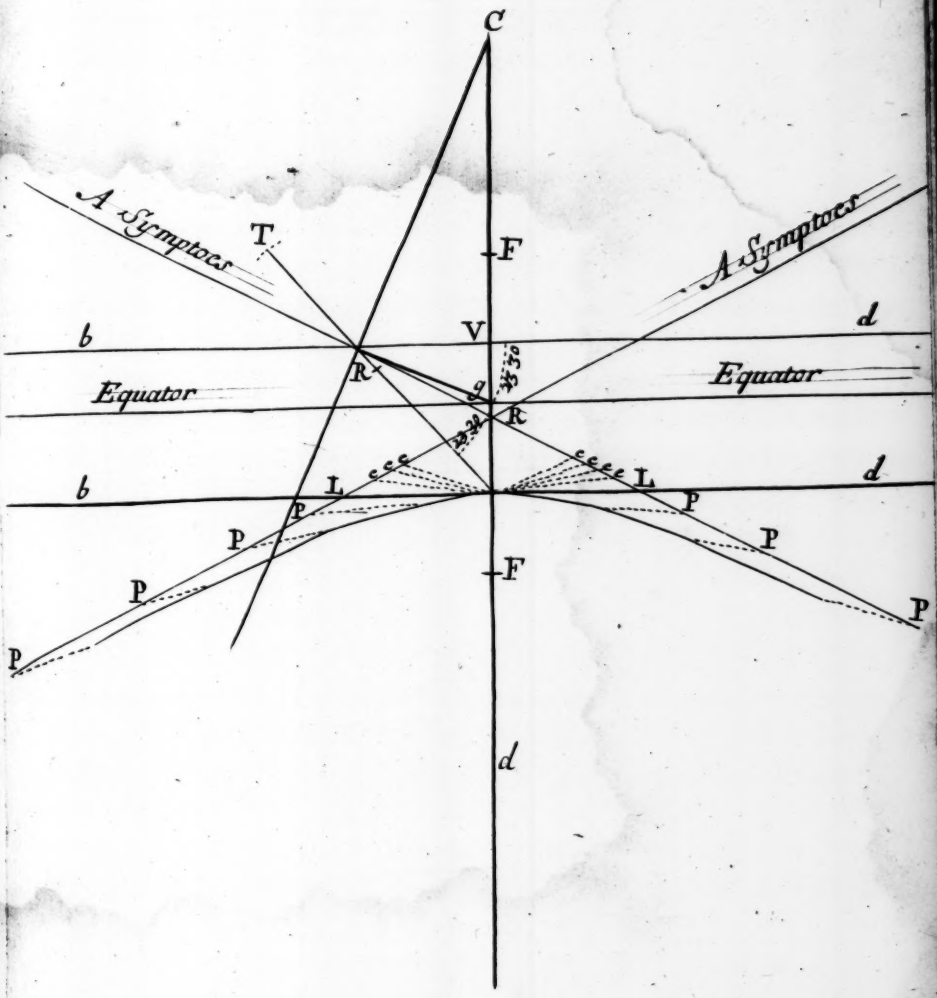
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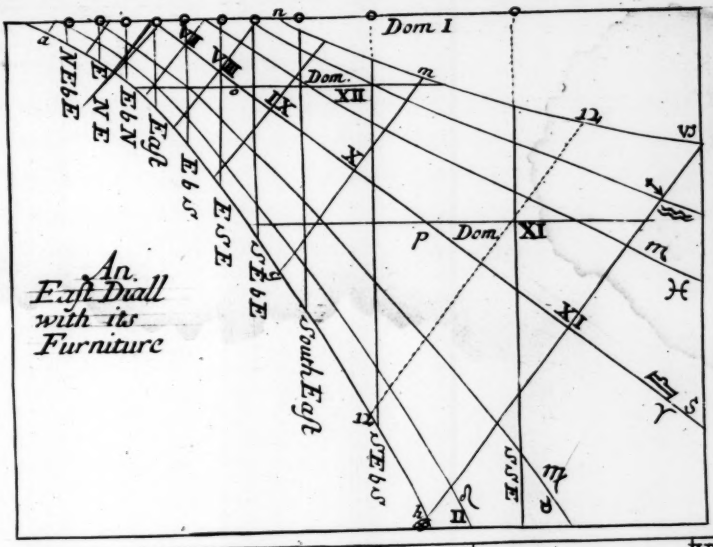
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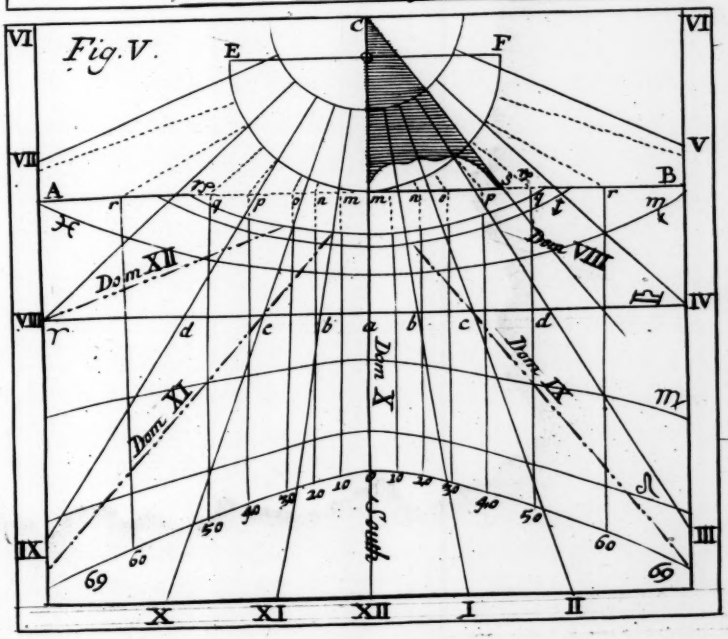
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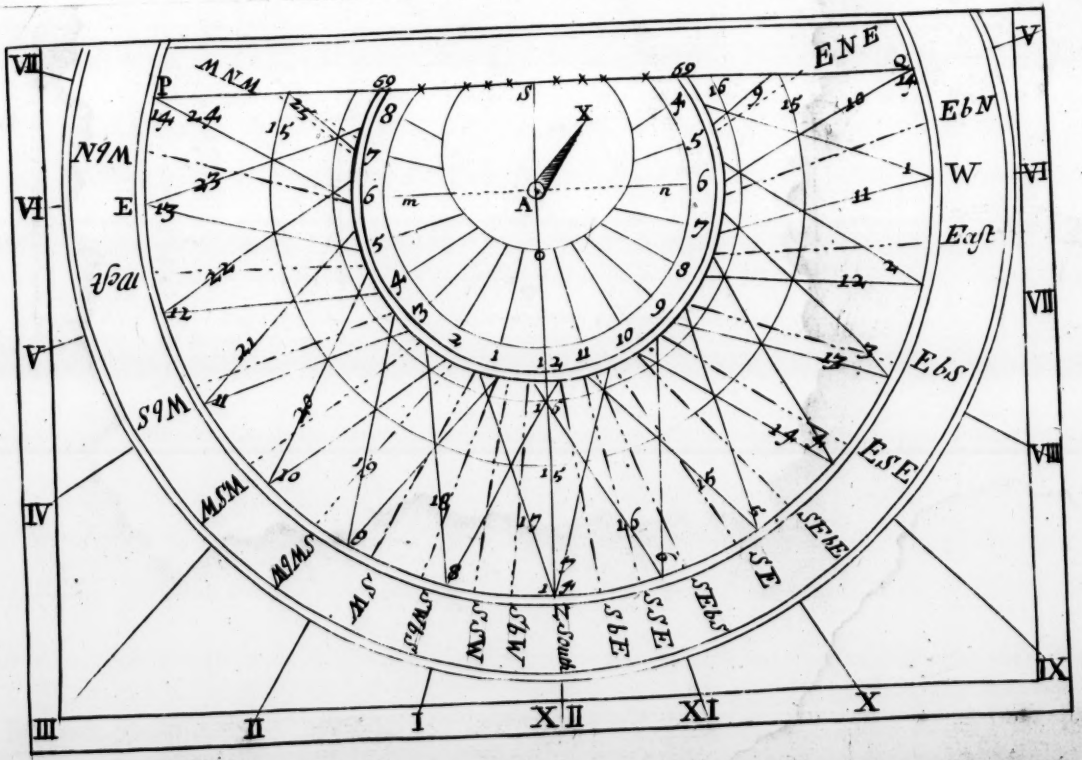


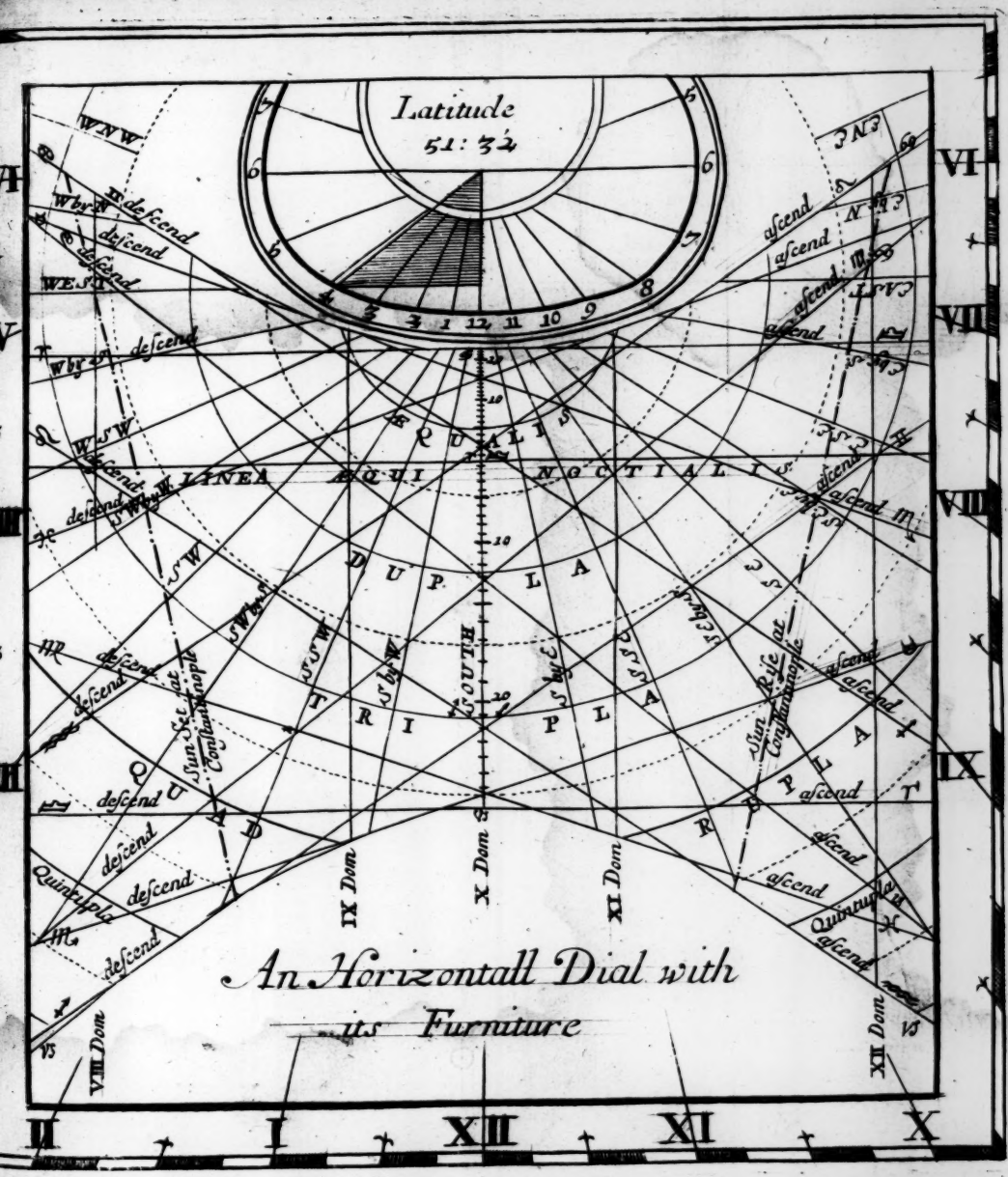
B


C
A Symptotes
T
F
A Symptotes
b
V
d
Equator
R
Equator
R
b
L
L
d
P
P
P
P
P
P
F
d


An East Diall with its Furniture
Dom I
Dom XII
Dom XI
NEbE
NE
NEbN
East
EbS
ESE
SEbE
SouthEast
SSE


Fig. V.
Dom XII
Dom VIII
Dom X
Dom XI
Dom IX
South


ENE
EbN
W
East
EbS
ESE
SEbE
SE
SSE
SEbS
SbE
S
SSW
SbW
SW
SWbS
SWbW
WSW
WbS
West
WbN
WNW
N
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
XII


Latitude
51: 32
WNW
descend
WSW
ascend
LINEA AEQUINOCTIALIS
EQUALIS
DUPLA
TRIPLA
QUADRUPLA
Sun Rise at Longitude
Sun Rise at Longitude
Quintupla
IX Dom
X Dom
XI Dom
VIII Dom
XII Dom
An Horizontall Dial with its Furniture

AN APPENDIX TO *CLAVIS HOROLOGIÆ*: OR AN EXPLICATION OF THE PYRAMIDICAL DYAL

Set up

In His Majesties Garden at *White-Hall*, Anno 1669.

IN WHICH

Very many Sorts of DYALS are contained; by which besides the Hours of all Kinds diversly expressed, many things also belonging to *Geography*, *Astrology*, and *Astronomy*, are by the Suns Shadow made visible to the Eye.

AMONGST WHICH,

Very many Dyals, especially the most Curious, are new Inventions, hitherto divulged by none.

All these Particulars are shortly, yet clearly set forth for the common Good,

By the Reverend Father *Francis Hall*, otherwise *Line*, of the Society of *Jesus*, Professor of *Mathematicks*.

Printed at *Liege*, by *Guillaume Street*, in the Year of our Lord 1673. And Reprinted at *London*, 1685.

AN
APPENDIX
TO
CLARIS HOROLOGIE:
OR A
EXPLICATION
OF THE
PYRAMIDICAL DYAL
AND
His Majesties Gracious Mandate
Ann. Anno 1659.

To the Lovers of all *Mathematical Learning.*

Most worthy Sirs,

KNowing that the Dyals that were set up in His Majesties Privy Garden in the Year 1669. by that most ingenious Mathematician Father Francis Hall, *alias* Line, of the Society of Jesus, and Professor of the Mathematicks at Liege in Germany, were a great Curiosity, and that which hath not been performed publickly in the World; and by reason that they have been some years demolished, and that the Fancy of them may give great satisfaction to those that are any ways inclinable to that Noble Art of Shadows, I have presumed to publish the Explanation of them as it was published by the said Father Line at Liege in Germany; and have no ways deviated from his own Explanation; but the manner of making of each Particular I have shewed in the foregoing Sheets, and in those places I have referred to the Cuts in this following Appendix: If my Endeavour be accepted by the young Students of this Age, I shall reap the Glory I do expect, and shall remain their Servant to present them

with ſomething that the Learned of ſome Ages thought (for thoſe whom I honour, and ſhall ever) not worthy of; in the mean time I ſhall reſt my ſelf contented to be thought ill of by thoſe whoſe Honeſty is leſs than their Wit, and whoſe Covetouſneſs more than both; and ſhall ſubſcribe my ſelf a Lover of all Lovers of Art, ſo long as my Name ſhall be called

JOHN HOLWELL.

AN

AN APPENDIX.

A Brief Explication of the Pyramidical Dyal *ſet up in His Majeſties Private Garden at* White-Hall, *July* 24. 1669.

THE Dyal being placed upon a Pillar by His Majeſties Order in the Privy Garden, it was intimated unto me by divers Worthy Perſons as a thing very expedient, that an Explication ſhould be publiſhed, of the Uſe of the ſeveral Dyals there contained: For although to divers of them were added a Verſe or two, explicating how the Hour, *&c.* was to be found by them; yet in regard many of them were new, and not to be found in any Author; and others belonging to Aſtronomy, Coſmography, *&c.* not ſo eaſily conceived by all, they judged very expedient a Declaration thereof ſhould be ſet forth, whereby ſuch as came dayly to ſee it, might receive more ſatisfaction.

Hereupon, having ſoon after the ſetting up of the Dyal, left *London*, and being arrived at my Lodging in the Country, I began the ſaid Explication; and being much deſirous to add ſome further Ornament to the Dyal already placed, I began the making of four Water-Dyals, to be placed at the four Corners of the Pyramidical Dyal in a competent diſtance from the ſame.

To this Undertaking I was moved, as well by the opportunity of a Fountain in the Privy Garden ſo near the Dyal; as alſo, for that Experience

perience had taught me, that such Dyals as formerly I had made to shew the Hour in several ways by Water, were for their Rarity and Novelty no less pleasing to the Beholder than the rest.

Being now very busie in these two Employments, and having towards the middle of Winter made a considerable progress therein, I received a Letter from a Friend at *London*, wherein he told me, that the Dyal, for want of a Cover (which according to His Majesties Gracious Order, should have been set over it in the Winter) was much endamaged by the Snow lying long frozen upon it; and that, unless a Cover were provided (of which we saw little hope) another or two such tempestuous Winters would utterly deface it. Hereupon I laid aside as well the said Explication, as these Water-Dyals, it seeming to no purpose, an Explication should come forth of the Use of the Dyal, when it was now rendred useless: Which Resolution being understood by some of those worthy Persons, who before had urged for the publishing the said Explication, they judged, that notwithstanding the Dyal it self should be rendred useless, yet the said Explication was not to be omitted; since thereby would be given occasion to some other skilful Mathematician (of which we have many in *England*) to set up another in place thereof, both more specious and durable, and adorned with more variety of Invention.

This Reason suting well with the Desire I formerly had of adorning His Majesties Garden with some Curiosity that might in its kind surpass what might elsewhere be found, I resolved to take in hand again the said Explication. Which that it may the better be performed, I will first enumerate the Parts or Pieces of which the whole Dyal consists, and then descend to the Dyals described on each particular Piece.

CHAP.

CHAP. I.

Of the ſeveral Parts of this Dyal; and of the Dyals deſcribed on each part in general.

THis Dyal ſtanding on a Pillar or Pedeſtal of Stone, conſiſts chiefly of ſix Parts or Pieces, one leſs than another; and placed one above another in form of a Pyramis, as you ſee in the Figure.

Of the Firſt Piece.

THE firſt and largeſt of theſe ſix Pieces, or Baſe of the ſaid Pyramis, is a round Table of about forty inches in Diameter, and ſome eight or nine inches in Thickneſs; the Edge whereof is cut into twenty equal Planes, which being made hollow, like ſo many Boxes of an inch deep, are covered each of them with a clear poliſh'd Glaſs, and on the inſide of each Glaſs is deſcribed a Dyal; whereof ſome of them ſhew the Hour according to the ancient, or *Jews* manner of counting the Hours; others, according to the counting uſed by the *Babylonians*; others, according to the *Italians*; others according to the way of counting uſed by *Aſtronomers*; and laſtly, others ſhew what Hour it is according to our uſual and ordinary way of counting the Hours uſed in moſt Parts of *Europe*. Theſe Twenty Dyals thus deſcribed on the Edge of this Table or firſt Piece, are all vertical declining Dyals; whoſe Style or Gnomon is either a Lions Paw, or Unicorns Horn, or ſuch like relating to His Majeſties Arms, and painted on the bottom of the Box, as ſhall be ſaid in the next Chapter.

Moreover, upon the upper part of this Table, are placed eight reclining Dyals, all made hollow, and covered with poliſh'd Glaſs like the former, but differ chiefly in this, that they ſhew only the uſual Hour in different ways; one of them ſhewing the Hour by the ſhade of the Style falling upon the Hour-lines; another by the ſhade of the Hour-lines falling upon the Style; a third without any ſhade either of Hour-lines or Style, *&c.*

Upon this Piece ſtand alſo four Globes, cut into ſeveral Panes; upon

On one of which Globes are described several Dyals belonging to Geography: on another, Dyals belonging to Astronomy, the other Dyals shewing several things appertaining to Astrology; as what Planet reigns every Hour, the Horoscope, Aspects of the Sun with the Stars, *&c.*

There are also belonging to this Piece, and issuing out of the sides thereof towards the East, West, North and South, four Iron Branches, supposing each of them a Glass-Bowl, which shew the Hour in four different ways, to wit, by the four Elements, as shall hereafter be said.

Of the second Piece.

THE second Piece of the Pyramis is also a round Table, almost like the former, but somewhat less; having only thirty inches in diameter, about the thickness of the first, held up by four iron Supporters. The Edge or Circumference of this Table is cut into sixteen equal Planes, all made hollow, and covered with Glass, like those of the first Table; but they differ from them in this, that here the Dyals are not described on the Glass Covers, but on the bottom of the Boxes: neither do they shew the Hour, but the different Rising of the more remarkable Stars, according to the three manners of Risings observed by Astronomers, to wit, the Cosmical Rising, the Acronical, and the Aeliacal, as shall be declared hereafter, when we speak of the Dyals of this second Piece. The Style to each of these Dyals is a little Star painted upon the inside of the Glass-Cover, the better to keep it from the weather.

Out of the sides of this Piece issue also four Branches, towards the East, West, North and South, and carry on each of them a Glass-Bowl to shew the Hour, like those of the first Piece, but in a different way: for one of them shews the Hour by a Style without a Shadow: another shews it by a Shadow without a Style, *&c.* whereas those of the first Table shew it by the four Elements, Fire, Water, Air and Earth, as shall be shewed in their due place.

On the upper part of this Table are placed eight reclining Planes; four whereof are covered each of them with a Plate of Looking-glass, on which the Hour-lines, or Style of a Dyal being painted, are reflected upon the bottom inclining Planes of the third Piece, and there shew the Hour, as shall be presently demonstrated. The other four have also Dyals upon them, which are to be seen each of them in a Looking-

Looking-Glaſs placed upon the ſaid bottom inclining Planes of the third Piece; of which we ſhall now ſpeak.

Of the Third Piece.

THE Third Piece of this Pyramidical Dyal is a great hollow Globe, of about twenty four inches in diameter; and is placed immediately without any Supporter, upon the ſecond piece. The Superficies of this Globe is cut into twenty ſix Planes; two whereof being Octogones, ſerve for top and bottom. The reſt are divided into eight equal reclining Planes, eight equal inclining Planes, and eight equal vertical or upright Planes. Theſe Planes are all of them made hollow like thoſe of the firſt and ſecond Piece. The Incliners are not covered with Glaſs, but left open, that they may the better receive and ſhew the Dyals reflected, as hath been ſaid, from the ſecond Piece.

Two of the eight upright Planes looking toward the North, have no bottoms, but are covered only with clear Glaſs, as ſerving only for windows to look into the Globe, and behold there the Dyals deſcribed on the Globe, which are ſeen as well without the ſame, as within. The other ſix have not only each of them a Cover of clear poliſhed Glaſs, with a Dyal deſcribed thereon, like thoſe of the firſt Piece; but have alſo a Glaſs for their bottom; which Glaſs is thinly painted over with white colour, to the end the ſhade of the Hour-lines drawn upon the Cover, may be ſeen as well within the Globe as without. On theſe bottom-Glaſſes are drawn ſeveral Pictures, holding either a Scepter, or a Troncheon, or the like, the end whereof points the Hour you look for.

Two alſo of the Recliners looking towards the North, have only a Glaſs-Cover ſerving for a window to look into the Globe. The other ſix have double Glaſs, like the former: Their Dyals are ſome drawn upon the Cover, others upon the bottom; but all ſo contrived, that the Hour cannot be known by them, but only by looking within the Globe.

Moreover, from the top of this Globe iſſue four iron Branches towards the four parts of the world, each of them carrying a Glaſs-Bowl, proportionably leſs than thoſe of the firſt and ſecond Piece: on which Bowl are alſo Dyals deſcribed, but different from the former, ſhewing the Hour according to the ſeveral ways of counting the Hours. Theſe Bowls are painted on the inſide with thick colour to

keep out the light, except a little place which is left clear, like a Star, for the Sun-beams to pass through and shew the Hour: and the place also where the Hour-lines are drawn, is only painted on the outside thinly with white colour, that the light of the Sun passing through, the said Star may be seen, and shew the Hour.

Of the Fourth Piece.

THE Fourth Piece standing on the aforesaid Globe, and held up by four iron Supporters, like to those which hold up the Second Piece, but proportionably less, is also a round Table of about twenty inches diameter, and six in thickness. The Edge of this Table is cut into twelve equal Superficies, not plain, as hitherto, but concave, as so many concave Semicylinders: on each of which is described a Dyal, which shews the usual Hour by the shade of a Flower-de-luce fixed at the top of each Semicylinder.

From the top of this Table issue forth four iron Branches, carrying each a Glass-Bowl just like those of the first, second and third Piece, though proportionably less. The Dyals described on these Glass-Bowls differ from those of the Third Piece, not because they shew only the usual Hour; but also because here the Hour-lines are all left clear for the Sun-beams to pass through; that by so passing, they may exhibit the like Dyal on the opposite side of the Bowl; which side is for that purpose thinly painted over with white colour, that the said Hours may be seen, and shew the Hour by their passing over a little Star painted in the middle thereof.

Of the Fifth Piece.

THE Fifth Piece standing upon the Fourth, and held up also by four iron Supporters, is a Globe of about twelve inches Diameter; whose superficies is cut into fourteen Planes; eight whereof are Triangles equal and equilateral; the other six are equal Squares. The Dyals described on these Planes, shew only the usual Hour by the shade of a Flower-de-luce fastned to the top or bottom of each Plane.

Of

Of the Laſt or Higheſt Piece.

THE Higheſt Piece or Top of the Pyramis, is a Glaſs Bowl of ſome ſeven inches Diameter, ſtanding upon a Foot of Iron placed on the middle of the Fifth Piece. The North ſide of this Piece is thinly painted over with white colour, that the ſhade of a little golden Ball that is placed in the middle of the Bowl, may be ſeen to paſs over the Hour-lines, which are drawn upon the ſaid white colour, and note the Hour. The Bowl is included between two Circles of Iron gilded, with a Croſs on the Top.

And thus much concerning the Parts of this Pyramidical Dyal in general.

To which may be added, That the firſt four Pieces have all their ſides covered with little Plates of black Glaſs, faſt cemented to the ſaid Pieces, except thoſe places whereon the Dyals are drawn; which being, as is ſaid, covered alſo with Plates of poliſhed Glaſs, there appears almoſt nothing on the outſide of this Dyal but Glaſs; which for the greater Ornament of the Dyal, the Angles or Corners where thoſe little Plates of black Glaſs are joyned together, are gilded as almoſt all the Iron-work of the Pyramid, as well Supporters, as Branches, Style, *&c.* are either wholly, or as much as ſerves for Ornament, covered in like manner with Gold.

CHAP. II.

Of the Twenty Vertical Dyals deſcribed on the Edge of the firſt Piece.

BY what is ſaid in the precedent Chapter, of the firſt Piece, it appears, that beſides the Dyals deſcribed on the four great Globes which ſtand on the ſaid firſt Piece, there are two and thirty Dyals belonging thereto, *viz.* twenty vertical or upright Dyals, eight reclining Dyals, and four ſpherical Dyals. Of the twenty verticals we ſhall now ſpeak in this Chapter, of the eight Recliners in the next; and of the four Spherical in the Fourth Chapter.

These Verticals being made hollow Boxes (as is said) covered with Glass, the Hour-lines of each of them are drawn upon the Glass; and the Style (which is either a Lions Paw, or Unicorns Horn, &c. is painted on the bottom of the Box; whence it follows, that whereas in the ordinary way of making Sun-Dyals, the shade of the Style or Gnomon passes over the hour-lines; here on the contrary, the shade of the hour-lines passes over the Style; so that whereas before, when the Sun did not shine, you saw nothing in the bottom of the Box, but a painted Lion or Unicorn, &c. So now assoon as the Sun shines, you may behold there a perfect Dyal, with all its lineaments and numbers exactly described, and just like the other drawn upon the glass-cover, as being only the shade thereof caused by the Sun-beams passing through the said Glass; which shady Dyal being moved by the motion of the Sun from one part of the said bottom to another, shews by passing over the paw of the Lion; for example, the same hour of the day which in the ordinary Dyal is shewed by the shade of the Style passing over the Hour.

These twenty Dyals thus described, are not all of the same kind, nor shew the time of the day all in the same manner, but in very different ways, according to the different ways of numbring the hours used by several sorts of people; some beginning to count their hours from Sun-rising, others from Sun-setting; others from Noon, others from Midnight. And again, of those who count from Sun-rising, some count always twelve hours from Sun-rising till Sun-setting for the day, and as many from Sun-setting till Sun-rising for the night, whether the days or nights be long or short: And these kind of hours are therefore called the unequal hours, as being longer or shorter, according as the days are now longer or shorter. Others there are, who also count from Sun-rising, but continue the number till next Sun-rising; counting always from Sun-rising till Sun-rising twenty four hours; according to which, it is always twenty four of the Clock at Sun-rising. Others on the contrary, count always twenty four hours from Sun-setting till next Sun-setting; so that when the Sun sets, it is always twenty four of the clock. Others count always twenty four hours, but begin at Noon, and end at next Noon, and with these it is always twenty four of the Clock at Noon. Lastly, Others begin at Midnight, and count twelve hours till Noon, and then twelve more till Midnight; and according to these it is always twelve of the clock at Noon and at Midnight.

The first of these five ways, and which divides the space between Sun-rising and setting into twelve equal parts, making thereby the hours unequal (as is said) that is, longer in Summer than in Winter,

is

is the moſt ancient of all; and are therefore called *Horæ antiquæ*. They were anciently uſed by the *Jews*, as is manifeſt by divers places of holy Writ: So that when in St. *Matthew*, ch. 27. v. 54. it is ſaid to have been darkneſs (at our Saviours Paſſion) from the ſixth hour to the ninth, it is to be underſtood according to our manner of reckoning the hours, that there was darkneſs from Noon till about three of the clock after Dinner: ſince, according to this counting by unequal hours, it is always at Noon ſix of the clock, and twelve at Sun-ſet. And for this reaſon they are called here in the Dyal *Horæ Antiquæ ſive Judaicæ*. They are alſo called *Horæ Planetariæ*; becauſe the ancient Aſtrologers ſuppoſed a new Planet to reign in each of theſe unequal hours.

The Second Way of counting 24 hours from Sun-riſing to Sun-riſing, is uſed by the *Babylonians*; and theſe hours are therefore called *Horæ Babylonicæ*, the *Babylonian hours*.

The Third Way of counting 24 hours from Sun-ſet to Sun-ſet, is uſed chiefly by the *Italians*; and therefore theſe hours are called *Horæ Italicæ*, the *Italian* hours.

The Fourth Way of counting alſo 24 hours from Noon or Mid-day till next Mid-day, is uſed by Aſtronomers in calculating the Places and Poſitions of the Stars and Planets in the Heavens, *&c.* and are therefore called *Horæ Aſtronomicæ*, Aſtronomical hours.

The Fifth and laſt Way, which counts Twelve hours from Midnight to Noon, and as many from Noon to Midnight, is uſed as well in moſt parts of *Europe*, as here in *England*, and is therefore ſtyled in this Dyal the uſual or vulgar way, and the hours *Horæ Vulgares*, the Vulgar or Uſual Hours.

Now, there being (as hath been ſaid) Twenty Dyals placed on the edge of this firſt Piece, there is allotted in the Dyal to each of the five ſorts four Dyals, which are ſo diſpoſed, that at any time of the day you may behold the hour repreſented in every of them five manner of ways. And that they may be the better underſtood, I have thought it convenient to ſet down one of each ſort, which by their Titles are eaſily known.

Fig.

Fig. 1.

For 1. Thoſe Four, whoſe Title is, *Per horas numeratas ab ortu Solis more antiquo, ſive Judaico*, and have a Red Lion painted on the bottom, ſhew by the ſhady Dyal paſſing over the paw of the Lion what of the Clock it is ſaid to be at *White-Hall* according to the Ancient, or *Jews* Account.

Fig. 2.

2. Thoſe Four whoſe Title is, *Per Horas numeratas ab ortu Solis, more Babylonico*, and have painted on their bottom a Harp with a Scepter, ſhew by the ſhady Dyal paſſing over the Scepter, what it is of the Clock it is at *White-Hall* according to the *Babylonian* way of counting the Hours.

Fig. 3.

3. Thoſe Four whoſe Title is, *Per horas numeratas ab occaſu Solis, more Italico*, and have on their bottom a Flower-de-Luce, ſhew by the like ſhady Dyal paſſing over the top of the Flower-de-Luce what of the Clock it is there according to the *Italian* Account.

Fig. 4.

4. Thoſe Four whoſe Title is *Per horas numeratas a Meridie, more Aſtronomico*, and have on their bottom a Unicorn, ſhew by the often mentioned ſhady Dyal paſſing over the tip of his Horn, what of the Clock it is ſaid to be according to the Account uſed by the Aſtronomers.

Fig. 5.

5. And Laſtly, Thoſe Four, whoſe Title is, *Per horas numeratas a Meridie & media nocte, more uſitato*, and have on the bottom a Lion painted in its natural Colour, ſhew by the ſhady Dyal paſſing over the Lions paw what of the Clock it is according to the uſual and ordinary way of reckoning the Hours.

So that for Example, If at the beginning of *July* (at what time the Sun riſes at Four of the Clock, and ſets at Eight) I find, by looking on the uſual Dyal that it is juſt eight of the Clock in the Morning, I ſhall find at the ſame time by the Ancient and *Judaical* Dyal, it is juſt three

of

of the Clock; by the *Babylonian*, to be Four; by the *Italian* Twelve; and by the Aſtronomical to be Twenty. And thus much for the Uſe of theſe Twenty Vertical Dyals.

Now the reaſon of their difference from the ordinary Dyals, which ſhew the Hour by the ſhade of the Style paſſing over the Hour-lines, is, that the Sun being moved in the ſame manner, whether the ſhade of the Hour-lines be moved over the Style, or on the contrary, the ſhade of the Style moved over the hour-lines, the ſelf ſame effect, in order to ſhewing the hour, muſt needs follow both ways, ſince the hour-lines are no other than the Sections which the Plains of the hour-circles in the Heavens make with the Plains of the Dyal; in each of which Plains the Style alſo is as inſenſibly differing from the Axis of the World.

From whence it follows, that the aforeſaid Dyals, being made according to the ordinary way of making the like vertical declining Dyals, are to be inverted, to the end they may ſhew the Hour.

CHAP

CHAP. III.

Of the Eight Reclining Dyals ſtanding upon the firſt Piece.

THE Eight reclining Dyals, being alſo made hollow, and covered with Glaſſes like the twenty Verticals we now ſpoke of, ſhew only the uſual hour, but perform it in different, or rather contrary ways one to another; for of thoſe four which ſtand upon the fourth part of the Table, one ſhews the hour by the ſhade of the Style paſſing over the hour-lines; another, on the contrary, ſhews it by the ſhade of the hour-lines paſſing over the Style. A third ſhews it both ways, as well by the ſhade of the Style paſſing over the hours, as the ſhade of the hours paſſing over the Style. The fourth ſhews the hour without ſhade either of Style or hour-lines.

In like manner, of thoſe four which ſtand on the North-part of the Table; in one you ſee the hour-lines, but no Style; in another you ſee the Style, but no hours: In a third you ſee neither Style nor hours, unleſs the Sun ſhine, as ſhall be declared by and by. In the fourth you ſee both hours and ſtyle, but in a different way from what hath been hitherto practiſed; for here you behold the ſtyle in the ſame ſuperficies with the hour-lines; whereas in the common practice of Dyalling, the ſtyle is always lifted above the ſuperficies, in which are the hour-lines, to the end it may caſt its ſhade upon them.

And thus much of theſe eight reclining Dyals in general; we ſhall now ſpeak of them in particular; and firſt of thoſe four which ſtand upon the South part of the Table.

Fig. 6.

The firſt of theſe four, whoſe Title is, *Per umbram Styli*, and ſhews (as is ſaid) the hour by the ſhade of the Style paſſing over the hour-lines, hath upon the Glaſs-Cover painted a little Star, which ſerves for the Style; and on the bottom are drawn the hour-lines, over which the ſhade of the ſaid Star paſſing, ſhews the Hour.

Fig.

Fig. 7.

The Second, whoſe Title is, *Per umbram horarum*, and ſhews the hour by the ſhade of the hour paſſing over the ſtyle, hath upon the Glaſs-cover painted a Harp, whoſe ſtrings are the hour-lines; and on the bottom is painted a Flower-de-luce, whoſe top ſerves for the ſtyle. So that by the ſhade of thoſe ſtrings paſſing over the Flower-de-luce, the hour is known.

Fig. 8.

The Third, whoſe Title is, *Per umbram tam ſtyli quam horarum*, and ſhews the hour as well by the ſhade of the hours paſſing over the ſtyle, as by the ſhade of the ſtyle paſſing over the hours, hath upon the glaſs-cover an Unicorn painted, with certain little ſtars on his back; each of which ſtanding for an hour, hath its number written over it: on the bottom are drawn the hour-lines of a Dyal, and by them a Scepter; ſo that when the Sun ſhines, you may behold the Unicorns ſhade, being moved by the motion of the Sun, to note the hour with the end of its Horn; and at the ſame time the ſhade of the ſaid little Stars to ſhew the ſame hour by paſſing over the Scepter.

Fig. 9.

The fourth and laſt of theſe, whoſe Title is, *Sine umbra vel ſtyli vel horarum*, and ſhews the hour without ſhade of either ſtyle or hours, hath painted upon the glaſs-cover a Flower-de-luce together with a Harp, whoſe ſtrings are the hour-lines, and the top of the Flower-de-luce is their ſtyle. Now out of this Flower-de-luce you ſhall ſee when the Sun ſhines, another Flower-de-luce of Light to ariſe, and by paſſing under the ſaid ſtrings of the Harp, to note the hour, and by conſequence, to ſhew (as is ſaid) the hour without ſhade of ſtyle or hours.

As for the reaſon of the Three firſt, there needs to add no more than what hath been ſaid of the Twenty Vertical Dyals. But concerning the Fourth, the reaſon why the Style or Flower-de-luce lies in the ſame ſuperficies with the hour-lines, is, That the ſaid luminous Flower-de-luce ariſing out of the painted Flower-de-luce, and ſhewing the hour, is reflected from a Looking-Glaſs placed upon the bottom of the Dyal.

Of the other Four Reclining Dyals which ſtand upon the North-part of the Table.

THE Three firſt of theſe Dyals are ſo contrived, that the hour cannot be otherwiſe known by them, than by looking through a little Ring placed on the Back of the Dyal; as ſhall be now explicated.

Fig. 10.

For in the Firſt, whoſe Title is, *Per horas latentes*, If you look on the Face of the Dyal, you perceive no hour-lines, but only a Style, that is, a Flower-de-luce painted upon the Cover: And on the contrary, if you look on the back of the Dyal through the ſaid Ring, you ſhall ſee the hour-lines, but no ſtyle, unleſs the Sun ſhine; for then you ſhall behold the ſhade of the ſaid Flower-de-luce paſs over the ſaid hour-lines, and note the hour.

Fig. 11.

In the Second, whoſe Title is, *Per latentem Stylum*, by looking on the Face of the Dyal, you behold only the hours; that is, you ſee only a Crown bedecked with Stars, each whereof ſtands for an hour: And on the contrary, by looking on the Back through a little Ring, you behold only the Style, that is, a Scepter, unleſs the Sun ſhine; for then you ſee alſo the ſhade of thoſe ſtarry hours paſs over the Scepter, and note the Hour.

Fig. 12.

In the Third, whoſe Title is, *Per latentes tam horas quam ſtylum*, you ſee neither hours nor ſtyle by looking on the Dyal; but if you look (as before) on the Back, you may behold the hour-lines; and if the Sun ſhines, you may perceive alſo a little Star paſs over them, and ſhew the hour.

Fig. 13.

Laſtly, In the Fourth, whoſe Title is, *Per tam ſtylum quam horas patentes*, there appears both ſtyle and hours; but the ſtyle is without ſhade, and the hours without lines; that is, upon the Glaſs-cover are painted certain little Stars, ſerving for the hours, and a Scepter, ſerving for the

the Style; out of which Scepter, when the Sun ſhines, you may behold another Scepter of Light to iſſue, and by paſſing under the ſaid ſtars, to ſhew the hour.

Now for the Reaſon why in the Three firſt you cannot ſee the hour, but by looking through the Ring on the Back of the Dyal, it is, becauſe their Bottoms being Glaſs thinly painted over with white colour, nothing can be ſeen by looking on the face of the Dyal, that is drawn on the lower ſide of the bottom-glaſs; and on the contrary, by looking on the Back, nothing can be ſeen that is drawn upon the glaſs-cover, but only the ſhade thereof when the Sun ſhines.

The Reaſon of the Fourth, is the ſame which was given for the Fourth of thoſe which ſtand on the South-part of the Table.

CHAP. IV.

Of the Four Glaſs Bowls ſtanding on the Four Branches of the Firſt Piece.

THeſe Four Bowls ſhew alſo the uſual Hour in four different ways; for one of them ſhews the Hour by Fire, another by Water, the Third by the Air, and the Fourth by the Earth, as we ſhall immediately declare.

Of the Firſt Bowl.

Fig. 14.

THE Firſt therefore, whoſe Title is, *Per Ignem*, and ſhews, as is ſaid, the hour by Fire, is a little Glaſs-Bowl filled with clear water. This Bowl hath about three inches in diameter, and is placed in the middle of another Sphere of about ſix inches in diameter, conſiſting of ſeveral Iron Rings or Circles, repreſenting the hour-circles in the Heavens. The hour is here known by applying your hand to the ſaid hour-circles when the Sun ſhines; for that Circle where you feel your hand burnt by the Sun-beams paſſing through the Bowl filled with water, ſhall ſhew the true hour; according to the Latine Verſe there adjoyned.

Cratem tange, manuſq; horam tibi reddet aduſta.

The Reaſon of this Dyal is, that the parallell'd Rays of the Sun paſſing through the ſaid little Bowl, are bended by the denſity of the water, into a Cone or Pyramis, whoſe vertex reaches a little beyond thoſe hour-circles, and there burns the hand applied; for ſo many Rays being all united into a Point, muſt needs make an intenſe heat, which heat is ſo powerful in the Summer-time, that it will fire a piece of Wood applied unto it.

Of

Of the Second Bowl.

Fig. 15.

THE Second Bowl, whose Title is, *Per Aquam*, shews the Hour by Water, that is, by the Rays of the Sun passing through the water with which the Bowl is filled, as in the precedent; which Rays, although they be bended by the density of the water, as before, yet they burn not, being cut off at their going out of the Bowl, by a little white colour laid thin on that part where they break out; making thereby only a round Circle of Light upon the said Colour; the Center of which Circle shews the Hour amongst the Hour-Circles there described on the said white Colour; as the Latine Verse doth also explicate:

Luminis hoc Centrum qui tangit, tangit & horam.

The Reason of this Dyal (besides what we now said of the bending of the Rays, is, that these hour-circles being no other than the Sections which the Planes of the Celestial hour-circles crossing each other in the Center of the Bowl, make in the superficies thereof, and the said Center of the Circle of Light made on the Bowl, answering perpetually to the Center of the Sun, it necessarily follows, that it shews always the true hour, as any one that knows but the first Principles of Dyalling, will conceive.

Of the Third Bowl.

Fig. 16.

THE Third Bowl, whose Title is, *Per Aerem*, and shews the hour without any style, is only filled with Air, and exhibits to the sight, when the Sun shines, two little Pictures of the Sun, like two small Stars within the Bowl, both which, if by moving your Eye, you bring under the same hour-circles described on the Bowl, or at least, parallel unto it, they shall shew the true hours, according to the Latine Verse there under-written.

Unam det geminus Sol horam, & vera patebit.

Now,

Now the reaſon why by thoſe little Pictures of the Sun ſeen both under the ſame hour-circle, or parallel to it, you find the hour, is, that thoſe hour-circles deſcribed on the Bowl, being the Sections which the Planes of the Celeſtial Hour-Circles make in the ſuperficies of the Bowl, (as was ſaid alſo of the ſecond Bowl) and theſe two little Suns being reflected one of them from the convex ſuperficies of the Bowl, and the other from the concave, it follows by the Rules of reflection, that thoſe two Pictures of the Sun are both ſeen in the ſame Plane; in which is alſo the Eye which ſeeth, and the Sun which is ſeen. Wherefore ſince the Sun is always in the Plane of the true Hour-circle, it neceſſarily follows that the Eye beholds both thoſe Pictures at the true hour; for although one reflection cannot ſufficiently determine the Eye to behold the Sun in the true hour-circle, yet two reflections ſuffice.

Where is alſo to be noted, that theſe three Bowls we have now ſpoke of, have this preheminence above all other Dyals depending on the ſhade of the ſtyle, that they ſhew the hour, when by none of the others it can be diſcerned; that is, when the Sun ſhines ſo dimly that it caſts no perceptible ſhadow.

Of the Fourth Bowl.

Fig. 17.

THE Fourth Bowl, whoſe Title is, *Per Terram*, ſhews what of the Clock it is in any part of the World, which is here performed by a Geographical Deſcription of the whole Earth upon the inward ſuperficies of the Bowl, together with a Meridian-circle moveable upon the North and South Poles, and the Equinoctial circle divided into its 24 equal hours, and faſtned to the ſaid Meridian, at the hour of Twelve; at which place alſo is erected a Flower-de-luce, and at the North-Pole is faſtned a Thred. The Bowl being thus prepared, and rightly placed, if you turn the ſaid moveable Meridian till the Flower-de-luce caſt no ſhade upon the Bowl, and then bringing the Thred over any part of the World till it croſs the Equinoctial-circle, you ſhall ſee the hour there noted belonging to that part or parts of the World over which the ſaid Thred paſſed; according to the Verſe there adjoyned.

Umbram tolle Orbi, totumq; ſtat Hora per Orbem.

CHAP.

CHAP. V.

Of the Four great Globes ſtanding on the Firſt Piece.

Of the Firſt Globe.

THE Firſt therefore of theſe Globes, whoſe Title is, *Horologiæ Geographica*, having about Thirteen inches in diameter, hath its ſuperficies cut into thirty two Planes; whereof twenty are Triangles all equal and equilateral; the other twelve are Pentagones, or five angled Figures, all of them likewiſe equal one to another. Some of theſe Pentagones are made hollow like Hemiſpheres, others like Cones, the reſt, as alſo the Triangles, are left plain. The Dyals deſcribed as well on the Pentagones, as on the Triangles, have for ſtyle, a ſharp-pointed Iron perpendicularly erected.

The Dyals deſcribed on the Pentagones, ſhew not only the ſituation of the more remarkable Countries in the World, but alſo what ſeveral actions are performed in them at the ſame time; for example, who are now at Dinner, who at Supper, who are riſing, who ſleeping, *&c.*

Fig. 18.

For thoſe two whoſe Title is, *Tempus ſurgendi*, ſhew by the ſhade of the ſtyle in what part of the World it is time of riſing, or ſix of the Glock in the Morning.

Fig. 19.

Thoſe, whoſe Title is, *Tempus Prandendi*, ſhew in the ſame manner, in what part of the World it is time of Dining or Mid-day.

Fig. 20.

Thoſe, whoſe Title is, *Tempus Cœnandi*, ſhew in what Countrey it is Supper-time, or ſix of the Clock at Night.

Fig. 21.

Thoſe, whoſe Title is, *Tempus Dormiendi*, ſhew where it is Midnight, or time of ſleeping.

Fig.

Fig. 22.

But those two, whose Title is, *Habentes Solem supra Caput*, shew by the shade of the style what People, whether by Sea or Land, have the Sun just over their Heads at such a time as you look upon the Dyal; which is performed by inverting that part of the Terrestrial Gobe which is included between the two Tropicks.

The Reason of which inversion is, that the shade of the style being always cast towards the contrary part to the Sun, that is, if the Sun be East, the shade falls towards the West, &c. it was necessary the Eastern part of the World should here lie Westwards, and the Northern Southwards. And thus much for the twelve Pentagones described on the Globe.

Fig. 23, & 24.

Now for the twenty equilateral Triangles; the Dyals described on them, shew only what of the clock it is in this or that particular place, according to the usual way of counting the hours from Midnight to Noon, and from Noon to Midnight; whereof only three Examples are here set down thus; one of these Dyals shews what of the Clock it is at *Jerusalem*, another at *Constantinople*, another in *Jamaica*, &c.

Of the Second Globe.

THE Second Globe, whose Title is, *Horologium Astronomicum ostendens*, &c. is just like the former, whereof we have now spoken; that is, the superficies thereof is cut into twelve Pentagones, and twenty Triangles; but the Dyals described on these Pentagones and Triangles, are much different from those of the former, as not only shewing the hour of the day, but divers other things belonging to Astronomy, as, the Azimuth, or distance of the Sun from the South, the Almicantarath, or height of the Sun above the Horizon, what hour he rises and sets; and the like; of which are now to treat.

Fig. 25.

1. The Dyal, whose Title is, *Azimuth Solis a Meridie*, shews by the shade of the style (which in each Dyal here also is perpendicularly erected)

erected) how many degrees the Sun is distant from the true South, at such time as you look upon the Dyal: The Lineaments of this Dyal are no other than the Sections which the Plains of the vertical Circles crossing each other, on the top of the style, make with the superficies of the Dyal.

Fig. 26.

2. The Dyal, whose Title is, *Altitudo Solis supra Horizontem*, shews how many degrees the Sun is elevated above the Horizon. The Lineaments of this Dyal are the Sections which the superficies of the Dyal makes with those cones whose bases are parallel to the Horizon, and whose common vertex is the top of the style, or center of the Earth.

Fig. 27.

3. The Dyal, whose Title is, *Incipit Aurora*, shews at what hour begins Break of Day, that is, when first the Crepusculine Arch begins to appear. The Lineaments by which this is here performed, are the Sections which the superficies of the Dyal makes with the cones, whose bases are parallel to the Equator, and whose common vertex is the top of the style, or the Earths Center.

Fig. 28.

4. The Dyal, whose Title is, *Sol oritur*, shews by the now named Sections of those Cones whose bases are parallel to the Equator at what hour the Sun riseth, and by consequence when he sets.

Fig. 29, & 30.

5. The Dyal, which hath for Title, *In quo Signo Zodaici sit Sol*, shews by the said Sections of the superficies of the Dyal with the Cones, whose bases are parallel to the Equator, in what part or sign of the Zodiack the Sun is; but because the shade of the top of the style falls twice every year upon the same Section, by reason of the Suns ascending and descending from the one Tropick to the other: therefore to avoid confusion, there are two Dyals of the same sort, one serving from the 10th. of *December* to the 10th. of *June*; the other from the 10th of *June* to the 10th. of *December*.

Fig. 31, 32.

The Dyal, whose Title is, *Dies Mensis*, shews by the like conical Sections now mentioned, what day of the Month it is; at least, as near as can be expected in so little a form. Here are likewise two Dyals of the same sort, for the reason now mentioned. And these Dyals within this second Globe we have hitherto spoken of, are all of them described on the Pentagones: Those which follow, are described on the Triangles.

Fig. 33.

7. The Dyal, whose Title is, *In qua parte Horizontis incipiat Aurora*, shews in what part of the Horizon begins the Break of Day, that is, in what part thereof begins first to appear the convex part of the Crepuscu-line Arch, whether just in the East, or in the North-East, or South-East, *&c.* and by consequence, in what part also the Evening Twilight ends. The Lineaments of this Dyal are the Sections which the Planes of the vertical Circles crossing each other on the top of the style, make with the plane of the Dyal.

Fig. 34.

8. The Dyal, whose Title is, *Duratio Crepusculi*, shews by the now often mentioned conical Sections of the superficies of the Dyal with the Cones, whose bases are parallel to the Equator, how long as well the Morning as Evening Twilight doth last, that is, how many hours are from Break of Day till Sun-rising; and from Sun-setting to the end of Twilight, or till dark night.

Fig. 35.

9. The Dyal, whose Title is, *In qua Cœli plaga existat Sol*, shews by the Sections of the vertical Circles, See *Num.* 7. in what part of the Heaven the Sun is, whether in the East or West, South-East, or South-West, *&c.*

Fig. 36.

10. The Dyal, whose Title is, *Amplitudo ortiva Solis*, shews by the conical Sections mentioned in *num.* 3. how many degrees the Sun rises wide of the true East-point, whether towards the North, or towards the South.

Fig.

Fig. 37.

11. The Dyal, whose Title is, *Quot horæ restent ad occasum Solis*, shews by the Sections of the *Italian* (*c.* 2. *n.* 3.) hour-Circles with the superficies of the Dyal, how many hours rest till Sun-set.

Fig. 38.

12. The Dyal, whose Title is, *Quota pars Diei sit elapsa*; shews by the sections of the unequal (as *n.* 3.) hour-circles, what part of the day, or space from Sun-rising to Sun-setting is now spent, whether the Third, or Fourth, or Fifth, *&c.*

Fig. 39.

13. The Dyal, whose Title is, *Declinatio Solis*, shews by the conical sections mentioned *n.* 3. the Suns declination, that is, how many degrees he is distant from the Equator.

Fig. 40.

14. The Dyal, whose Title is, *Qua hora Sol perveniat ad verum Orientem*, shews by the same conical sections, at what hour the Sun comes to be just East, and by consequence, at what hour after Dinner it will be just West.

Fig. 41.

15. The Dyal, whose Title is, *Refractio Solis*, shews by the conical sections, spoken of *n.* 2. the Suns Refraction, that is, how many minutes he appears to be elevated above his true height, by the bending of his Rays in passing through our thick Atmosphere.

Fig. 42.

16. The Dyal, whose Title is, *Quoties umbra contineat corpus erectum*, shews by the shade of the style falling upon the aforesaid conical sections mentioned in *n.* 2. how often the shadow of a Body perpendicularly erected upon a Plain parallel to the Horizon, contains the length of the same Body.

Fig. 43.

17. The Dyal, whose Title is, *Longitudo Diei*, shew by the shade of the style falling upon the conical sections spoken of, *n.* 1. the length of the day, that is, how many hours are between Suns-rising and setting.

Fig. 44.

Lastly, The Dyal, whose Title is, *Quot sint horæ elapsæ ab ortu Solis*, shews, by the shade of the Style falling upon the sections which are made in the superficies of the Dyal, by the Plains of those circles which divide all the parallels of the Suns dayly motion into twenty four equal parts, according to what was said, *c.* 2. *n.* 2. how many hours have passed since Suns-rising.

Of the Third Globe.

THE Third Globe, whose Title is, *Horologium Uranographicum*, is about the same bigness with the two former; but the superficies thereof cut into twenty Triangles, all equal and equilateral, some whereof are made hollow like Cones, the rest left plain. The Dyals described on these Triangles, shew what situation or posture the Heavens have at any time of the day, when the Sun shineth, that is, what stars are rising, what setting, what stand just over your head, *&c.* So this Globe standing immoveable, performs, by the shade of the styles belonging to these several Dyals, that in effect, which a Celestial Globe, whereon all the fixed stars or constellations are painted, would do, if being rightly placed, it were continually turned about, according to the Suns dayly motion: where is to be noted, that here are always two Dyals of each sort, one serving one half year, and the other another, for the reason given in the Fifth Dyal of the Second Globe.

Fig. 45, 46.

1. Therefore, Those two Dyals, whose Title is, *Constellationes Orientes*, shew by the shade of the style, what Constellation or Company of stars begin then to arise above the Horizon, provided that you look upon the Dyal belonging to the time of the year which you are now in, according

according to what was now ſaid. The lineaments of theſe Dyals are the Sections which the Plain of the Ecliptick Cirele makes with the ſuperficies of the Dyals at ſuch time as thoſe ſeveral Conſtellations noted upon the Dyal, begin to riſe.

2. Thoſe two, whoſe Title is, *Conſtellationes Occidentes*, ſhew in like manner what Conſtellation begins to ſet, or go under the Horizon. The Lineaments of theſe two Dyals are the Sections which the Plain of the Ecliptick Circle makes with the ſuperficies of the Dyal at ſuch time as this or that Conſtellation begins to ſet.

3. Thoſe two Dyals, whoſe Title is, *Conſtellationes exiſtentes in Meridie*, ſhew what Conſtellation begins to paſs the Meridian Circle, or full South, which is here performed by the ſections which the Plain of the Ecliptick Circle makes with the ſuperficies of the Dyal, when the ſeveral Conſtellations there noted, begin to paſs the Meridian Circle.

4. Thoſe two, whoſe Title is, *Conſtellationes exiſtentes in ipſo Oriente*, ſhew what Conſtellations ſtand juſt Eaſt, whether it be in the Horizon, or elevated above the ſame, which they perform by thoſe Sections which the Plain of the Ecliptick makes with the Plain of the Dyal, when ſuch Conſtellations as are there noted, do paſs the Eaſt Circle, or firſt Vertical.

5. Thoſe two, whoſe Title is, *Conſtellationes exiſtentes in ipſo Occidente*, ſhew on the contrary what Conſtellations ſtand juſt Weſt, which is done by the like Sections made by the Ecliptick, when thoſe Conſtellations begin to paſs the true Weſt.

6. Thoſe two Dyals, whoſe Title is, *Conſtellationes exiſtentes ſupra Caput*, ſhew what Conſtellation ſtands over your head; which is alſo done by the aforeſaid Sections made when the Conſtellations there noted, paſs the Zenith, or vertical Point.

Now theſe twelve Dyals being all made (as is ſaid) by the Sections of the Ecliptick with the ſuperficies of the Dyal, it will be ſufficient to give here a Diagram of the two firſt.

But becauſe theſe two Dyals ſhew only what ſituation the ſtars have in the day-time, when the ſtars cannot be ſeen, unleſs there ſhould happen a total Eclipſe of the Sun, there are therefore deſcribed on the ſame Globe ſix other Dyals, ſhewing what ſituation the ſtars will have at 8 of the Clock at Night; a time proper to behold them, and ſee the truth of the Dyal.

Fig.

Fig. 47, 48.

7. Thoſe two Dyals, whoſe Title is, *Conſtellationes exiſtentes in Oriente hora octava veſpertina*, ſhews what Conſtellation will ſtand juſt Eaſtward at Eight of the Clock at Night; which is here performed by the Sections which the ſuperficies of the Dyal makes with thoſe Cones whoſe baſes are parallel to the Equator, and whoſe common Vertex is the top of the ſtyle, or Center of the Earth.

8. Thoſe two, whoſe Title is, *Conſtellationes exiſtentes in Occidente hora octava veſpertina*, ſhew by the fore-named Sections, what Conſtellations will be juſt Weſtward at Eight of the Clock in the Evening.

Laſtly, Thoſe two, whoſe Title is, *Conſtellationes exiſtentes in Meridie hora octava veſpertina*, ſhew by the Sections which their ſuperficies make with their aforeſaid Cones, what Conſtellation at Eight of the Clock at Night will be juſt South.

And theſe ſix Dyals being made by the Sections of the ſame Cones, it will ſuffice to place here the Diagram of the two firſt: And thus much of the Third Globe,

Of the Fourth Globe.

Fig. 49.

THE Fourth and laſt Globe, whoſe Title is *Horologium Aſtronomicum*, is alſo cut into twenty Triangles, equal and equilateral, juſt like the Precedent.

The Dyals deſcribed on theſe Triangles, belong to Aſtrology, and are placed here for thoſe who are delighted with ſuch conjectural Uncertainties. Theſe Dyals are as follow.

1. The Dyals, whoſe Title is, *Domus Aſtrologica Solis*, ſhews in which of the twelve Aſtrological Houſes, deſcribed according to the way of *Regiomontanus*, the Sun is at the time you behold the Dyal. The Lineaments of this Dyal are the Sections which the plains of thoſe Circles, which croſſing each other on the North and South Points of the Horizon, divide the Equator into 12 equal parts, beginning at the Eaſt point of the Horizon, and ſo deſcending, make with the Plain of the Dyal.

Fig.

Fig. 50, 51.

2. Thoſe two Dyals, whoſe Title is, *Signum horoſcopans*, ſhew the Horoſcopon (as Aſtrologers term it) that is, which of the twelve Signs do begin to riſe above the Horizon; which is here performed by the Sections which the Plain of the Ecliptick makes at the time they begin to riſe, with the ſuperficies of the Dyal.

3. Thoſe, whoſe Title is, *Signum culminans*, ſhew by the like Sections of the Ecliptick with the ſuperficies of the Dyal, what Sign of the Zodiack is in the Meridian, or full South. Wherefore theſe four Dyals being made by the ſame ſections, it ſuffices alſo to put a Diagram only of the two firſt.

Fig. 52.

4. Thoſe Dyals which ſerve here for the ſeveral days of the week, ſhew what Planet reigns, according to the Opinion of ancient Aſtrologers, every hour of the day: So the Dyal, whoſe Title is, *Dominatur die Lunæ*, ſhews what Planet reigns any time of the day on *Monday*.

Fig. 53.

And in the ſame manner, the Dyal, whoſe Title is, *Dominatur die Martis*, ſhews what Planet reigns at any time on *Tueſday*. And ſo of the reſt. The Lineaments of theſe Dyals being all alike, to wit, the ſections which the plains of the unequal hour-circles make with the ſuperficies of the Dyal, it will be ſufficient alſo to put here the Diagrams of the two firſt.

Fig. 54, 55.

5. Thoſe two Dyals, whoſe Title is, *Conjunctio Solis cum Stellis fixis*, ſhew with which of the more remarkable fixed Stars the Sun is in conjunction, or under the ſame Circle of Longitude.

Laſtly, Thoſe two, whoſe Title is, *Varii Aſpectus Solis cum Stellis fixis*, ſhew the other Aſpects of the Sun, as the Trine-Aſpect, the Quadrat, *&c.* with the ſaid fixed ſtars. Theſe four Dyals being made much alike, as made by the ſections which the ſuperficies of the Dyal makes with the cones whoſe baſes are parallel to the Equator, and common Vertex, is the top of the ſtyle, or center of the Earth, it will ſuffice to place here alſo the Diagram of the two firſt. And thus much of the Dyals belonging to the firſt Piece.

CHAP.

CHAP. VI.

Of the Dyals described on the Edge of the Second Piece.

Fig. 56, 57.

1. THose Dyals which are described on the Edge of this Table, have for Title, *Stellæ Orientes Cosmicæ*, shew what Stars rose cosmically (that is to say) rose at the same time when the Sun rose, on the day you look upon the Dyal; provided you look upon the Dyal belonging to the time of the Year, here being two Dyals of the same sort, one for the one half of the Year, and another for the other half.

2. Those Dyals, whose Title is, *Stellæ Orientes Acronicæ*, shew what Star will rise acronically, that is, will rise just at Sun-setting; where also Care is to be had, that you look upon the Dyal agreeable to the time of the Year.

Lastly, Those Dyals, whose Title is, *Stellæ Orientes Heliacæ*, shew what Stars rise that day Heliacally, that is, what Star, which for some time before, had, by reason of its nearness to the Sun, lay hid, begins now to appear again, by getting out of the Sun-beams.

Now the Lineaments of these Dyals, being all of the same sort, to wit, such conical sections as the Plain of the Dyal makes with the Cones, whose Bases are parallel to the Equator, and whose common Vertex is at the top of the style, that is, at the middle of the little painted Star, which here in each Dyal represents the Style: This, I say, being so, it will suffice here to place two Diagams of the first sort.

CHAP.

CHAP. VII.

Of the Eight Reflecting Dyals placed on the Top of the Second Table.

THE Reason why these Dyals placed upon the second Table were made by reflexion of Looking-Glasses, was not so much for variety, as for necessity; for the Table standing high, the Dyals placed on the upper part thereof, could not have been seen, but by being reflected on the bottom or inclining Plains of the great Globe, which stands (as is said in the first Chapter) upon this second Table; whereas, now being reflected, they are very well seen upon the said bottom, together with their Titles, as followeth:

Fig. 58.

1. The Dyal, whose Title is, *Per horas sine stylo*, hath its hour-lines described, and visible on the bottom of the aforesaid Globe, but by the style, which is a Flower-de-luce, being painted upon a Looking-Glass placed on the Table, appears not, but only the shadow thereof appears; which being reflected upon the said hour-lines, drawn on the bottom of the Globe, shews the hour, according to the Verse there adjoyned:

En Horas! stylus a lucenti Sole petendus.

These hour-lines being no other than the sections which the Plains of the ordinary hour-circles, crossing each other upon the top of the said Flower-de-luce, make with the Plain of the Dyal, no more needs to be said but that it is a reflex Dyal, supposing always the Sun as much depressed under the Horizon, as it is *de facto* elevated above it.

2. The Dyal, whose Title on the contary, is, *Per stylum sine horis*, hath its style (which is a Lions Paw) painted upon the bottom of the Globe, and therefore easie to be seen; but the hour-lines being drawn upon a Looking-Glass placed upon the Table, appear not, only their shadow reflected upon the said Lions Paw, shew the hour, according to what the Verse there intimates;

Da mihi Phœbe *horas, horamq; tibi ungue notabo.*

This Dyal being only the former invers'd, according to what was said of the like inversion in the second Chapter, there needs no more to be

 added:

added: As also neither is it needful to say any more of the other, which there in the self-same manner shews the hour by the hour-lines reflected upon the end of an Unicorns Horn; according to the Verse;

Sol mihi Lucæ dat horas, horam do tibi Cornu.

3. In the Dyal, whose Title is, *Sine Horis vel Stylo*, appears neither hour-lines nor Style, unless the Sun shine; for then you see them both; that is, you see the shadow of both style and hour-lines reflected from the Looking-Glass, upon which the said Hour-lines are drawn.

This Dyal differing nothing from an ordinary reclining Dyal declining, we need say no more thereof; as neither of the other four, which also differ no otherwise from ordinary Dyals, than that they are not to be otherwise seen than each of them in a Looking-Glass placed on the bottom of the great Globe. Wherefore it will suffice to place the Diagrams of the two first.

CHAP.

CHAP. VIII.

Of the Four Dyals ſupported by the Four Branches of the Second Piece.

THeſe Four Dyals are drawn each of them upon a Glaſs-Bowl of about five Inches diameter, and ſhew the uſual hours by four different ways, *viz.* by a ſhade, without any ſtyle, by a ſtyle without any ſhade, by a ſtyle and ſhade, and without either ſtyle or ſhade.

Fig. 60.

1. The Dyal, whoſe Title is, *Per ſtylum ſine umbra*, ſhews the hour by moving the ſtyle (which here is a Flower-de-luce fixed on a moveable Equator) to and fro till it caſt no ſhade upon the Bowl; which being done, the hour ſought for ſhall ſtand juſt under the ſtyle; as the Verſe there added declares:

Nulla ſit umbra ſtylo; veram ſtylus indicat horam.

Now the Reaſon, why the ſtyle caſting no ſhade on the Bowl, ſtands over the true hour, is, that theſe hours lying all in the ſections, which the Plains of the hour-circles make in the ſuperficies of the Bowl, it is neceſſary that then the top of the ſtyle be in the Plain of the ſame hour-circle, in which at that time is alſo the Center of the Sun.

Fig. 61.

2. In the Dyal, whoſe Title is, *Per umbram ſine ſtylo*, the hour is found by obſerving where the part of the Bowl enlightned by the Sun, meets with the part not enlightned; for this meeting ſhews the hour, as the there adjoyned Verſe explicates:

Vis horam? lucemq; inter tenebras require.

The Reaſon whereof is, That the Sun, by reaſon of its immenſe diſtance enlightning without any conſiderable difference, the one half of the Bowl, and the hour-points being all noted in the Equator of the Cone or Sections which the Plain of the Equator paſſing through the Center of the Bowl, makes in the ſuperficies thereof, the ſaid termina-

tion of Light must needs fall upon the true hour-point, provided that the Dyal be once rightly placed.

Fig. 62.

3. The Dyal, whose Title is, *Per Stylum & Umbram*, shews the hour by the shade of a style perpendicularly erected upon the superficies of the Bowl, and therefore differs nothing from an ordinary Dyal described on the convex superficies of a Globe. There are three such Dyals placed upon this Bowl, to the end that when the shade of the style ceases, by reason of the convexity of the Bowl, to shew the hour in one, may shew it in another.

Fig. 63.

Lastly, The Dyal, whose Title is, *Sine Stylo vel Umbra*, shews the Hour without either style or shadow; for if you place your-self, so as to behold your face in the middle of the little convex Looking-Glass which is there placed on the South-pole of the Bowl, you shall at the same time, if the Sun shine, behold the Picture thereof at the true Hour; according to the Verse there adjoyned.

Si cui anti Speculum Horam dat tibi Solis Imago.

The Reason whereof is, that the Eye, when placed, as is said, being in the Axis of the World, and by consequence, in the Plain of all the hour-circles, and therefore in the Plain of the true hour-circles, in which Plain also, the center of the Sun being necessarily placed, it follows that the said Picture of the Sun appears at the true hour, since by the Rules of Reflexion, the Eye seeing, and the Point seen, are in the same Plain with the Point of the Reflexion.

As for the Hour-lines of these four Dyals, they are no other than the Sections, or some point of them, which the Plains of the hour-circles make in the superficies of the Bowls; which Plains in the first, second, and fourth, cross each other in the Center of the Bowl; but in the third, they cross one another at the top of the Style.

CHAP.

CHAP. IX.

Of the Dyals deſcribed on the great Globe which ſtands on the Second Table.

THis Globe having Eight reclining Plains, eight inclining, and Eight upright Plains, the Dyals deſcribed on them, are as followeth;

1. Six of the Eight upright Plains being made hollow, like thoſe Twenty on the edge of the firſt Table, are covered alſo with Glaſs, and Dyals deſcribed on them, juſt like thoſe twenty; the difference only being, that here the bottoms are alſo covered with Glaſſes thinly painted over with white colour; to the end the Dyals may be ſeen as well within the Globe, as without: To which purpoſe, two of theſe upright Plains, looking towards the North, are covered only with clear Glaſs, as ſerving for Windows to look into the Globe. On the ſaid Bottom-Glaſſes are drawn ſeveral Pictures; as of their Majeſties, the Queen Mother, the Duke of *York*, Prince *Rupert*, &c. In His Majeſties Picture the Hour is ſhew'd by the ſhade of the Hour-lines paſſing over the top of the Scepter. In the Pictures of the two Queens, it is ſhew'd by the like ſhade paſſing over the top of a Flower; and in the other three, by paſſing over the end of a Troncheon, which each of them hold in their hands; under each Picture is written a Chronograph for the Year 1669. in which Year the Dyal was ſet up; and ſutable to the Perſon.

Which Chronographs, according to the Order now named, are as followeth:

1. Regnet DiV CaroIVs IMperetqVe BritannIs

2. FaXIt Regina Det Regi RegnoqVe ProLem CatharIna,

3. RegIna Mater nato sIbI Carolo DIV frVatVr.

4. IaCobVs & RegIs frater, & InsignIs BrItanniæ aDMIraLIVs,

5. FILIVs SeCVnDVs RegIs BoheMIæ.

These

These six Vertical Dyals being all alike, it will suffice to place here the Diagrams of the two first.

Fig. 64, 65.

As for the Dyals described on the reclining Plains of this Globe, they are in substance like those Recliners placed upon the first Table, except that, whereas those of the first are most of them made to shew the hour by looking on the outside of the Dyal, here no hour can be seen but by looking through the aforesaid Windows into the Globe; which doing, you shall behold in one a Star, in another a Flower-de-luce, shewing the hour, by passing over the hour-lines; in a third, you shall behold a Lion, with certain Stars on his back, each whereof represents an hour, to pass under a Cloud, and so by successively hiding them, to note the hour; and the like of the rest of these Recliners. As for the reclining Plains, which are placed on the bottom of the Globe: the Dyals belonging thereto, are already explicated in the precedent Chapter, as made by reflection of Looking-Glasses, *&c.*

CHAP.

CHAP. X.

Of the Four Glaſs-Bowls ſupported by the Four Branches of the Great Globe.

OUT of the top of the great Globe iſſue (as was ſaid in the firſt Chapter) four Branches, each bearing a Glaſs-Bowl, like thoſe of the firſt and ſecond Piece, but ſomewhat leſs in proportion to the Pyramis. Theſe four Bowls are gilded over, except where the Hour-lines are drawn, which is thinly painted over with white colour, to the end the Sun-beams paſſing through a little Star left clear on the top of the Bowl, and making the like Star of Light upon the hour-lines, may be ſeen to note the hour.

Theſe Dyals ſhew the hour according to the different ways of numbring the hours, uſed by ſeveral Nations, as was ſaid in the ſecond Chapter.

Fig. 66.

1. The Dyal, whoſe Title is, *Per horas Italicas*, ſhews by the ſaid luminous Star paſſing over the hour-lines, what hour it is to be ſaid according to the *Italian* Account, which numbers from Sun-ſet to Sun-ſet 24 hours. Theſe hour-lines are the Sections which the Plains of the *Italian* hour-circles croſſing each other in the middle of the ſaid Star placed on the top of the Bowl, make in the ſuperficies thereof.

Fig. 67.

2. The Dyals, whoſe Title is, *Per horas Babylonicas*, ſhews in like manner, what hour it is according to the *Babylonians* way of reckoning, who count 24 hours from Sun-riſing till next Sun-riſing, which it performs by the ſections which the Plains of the *Babylonian* hour-circles croſſing each other in the middle of the ſaid Star, make in the ſuperficies of the Bowl.

Fig.

Fig. 68.

3. The Dyal, whose Title is, *Per Horas Astronomicas*, shews by the like Star, the hour according to the Astronomical Account, which numbers 24 hours from Noon till next Noon. This Dyal is made by the like sections of the usual hour-circles crossing each other in the middle of the said Star; the Numbers set to the hours being only different, that is, One of the Clock in the Morning is here called Thirteen, and Two Fourteen, and Three Fifteen, *&c.*

Fig. 69.

Lastly, The Dyal, whose Title is, *Per Horas antiquas, sive Judaicas*, shews the Hour according to the ancient way of numbring the hours, *viz.* counting always 12 Hours from Sun-rising till the setting thereof: Wherefore the sections by which this Dyal is made, are those which the Plains of the unequal hour-circles make in the superficies of the Bowl; which Plains also cross each other in the middle of the Star, or Style of the Dyal.

And thus much of the Third Piece, with the Branches belonging to it. The Diagrams belonging to these Four Bowls are as followeth:

CHAP.

CHAP. XI.

Of the Three uppermoſt Pieces of the Pyramis.

THE Dyals belonging to the three lower Pieces of the Pyramis, being explicated in the precedent Chapters, we will now in this Chapter explicate the reſt, that is to ſay, the Dyals appertaining to the Three higheſt, or uppermoſt parts thereof.

Fig. 70.

The Fourth Piece therefore, conſiſting (it is ſaid in the firſt Chapter) of twelve concave Semi-Cylinders, and ſtanding upon the great Globe, held up by four Supporters, like thoſe which hold up the ſecond Piece, but leſs, hath upon each of thoſe Semi-Cylinders a Dyal deſcribed, ſhewing the uſual hour by the ſhade of a Flower-de-luce fixed at the top of a Semi-Cylinder.

Out of the top of this Piece iſſue four Branches, carrying each a little Glaſs Bowl, ſhewing alſo the uſual hour by the Light of the Sun penetrating through the hour-lines (which for that purpoſe are left tranſparent, the reſt of the Bowl being gilded over) and paſſing over a little Star painted on the lower part of the Bowl.

Fig. 71.

The firſt Piece, conſiſting of 8 plain Triangles, equal and equilateral, and ſix equal ſquares, and held up alſo by four Supporters, hath in like manner Dyals deſcribed thereon, ſhewing the uſual hour by the ſhade alſo of a Flower-de-luce.

Fig. 72.

The Sixth and laſt Piece, or top of the Pyramis, is a great Glaſs-Bowl ſtanding upon the Fifth, ſupported by a Foot of Iron, and encompaſſed with two Iron Circles, having on the Top a Croſs. This Bowl alſo ſhews the uſual hour by the ſhade of a little Golden Ball placed in the middle of the Glaſs.

The Dyals belonging to these three Pieces, shewing only (as is said) the usual hour, it will suffice to set down a Diagram for each Piece.

As for the Reason of these Dyals, they all shewing only the usual hour, there needs no more to be said than what hath been already of the like, *viz.* that in the Fourth and Fifth Pieces, the Plains of the Hour-circles cross each other upon the top of the Flower-de-luce; but in the Sixth, they cross on the Center of the little Ball placed in the middle of the great Bowl.

The Dyals of the four little Bowls supported by the Branches, are no other than the Astronomical Dyal of the precedent Chapter, inverted, and only differ in the Numbers set to the Hours.

And thus much concerning what in this short Tract was intended to wit, the Use and Reasons of the Dyals described on the said Pyramis.

FINIS

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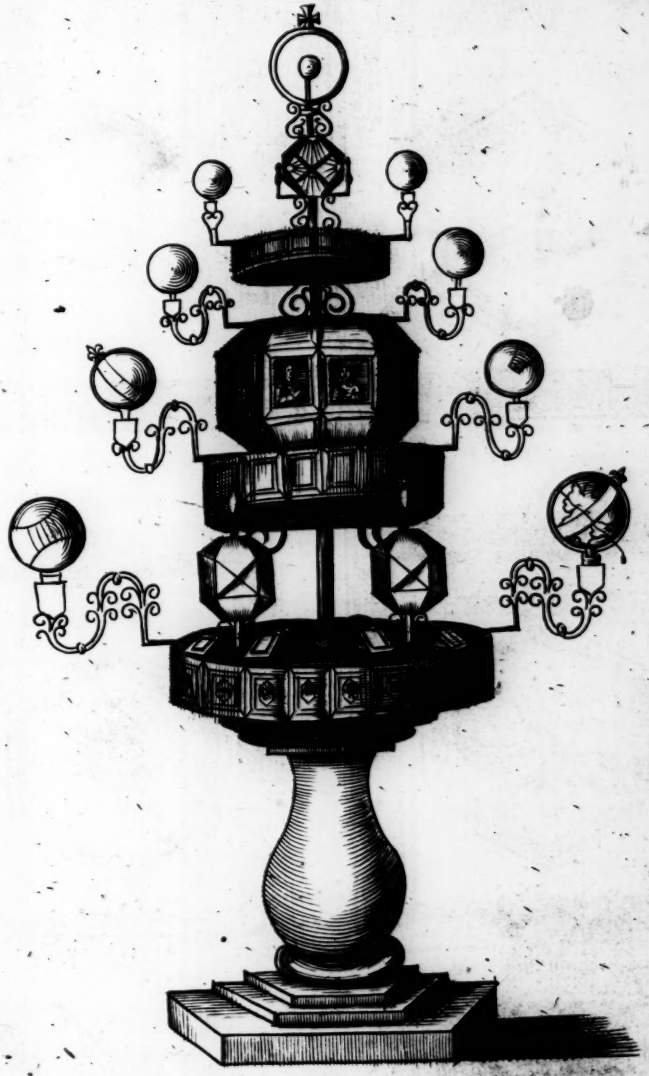
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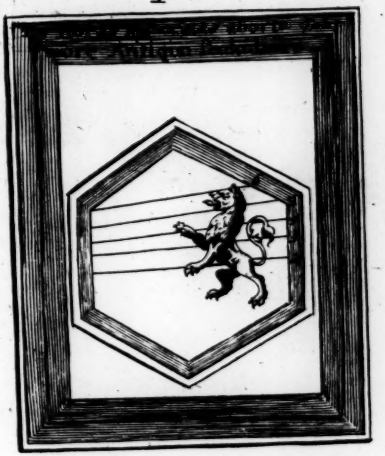
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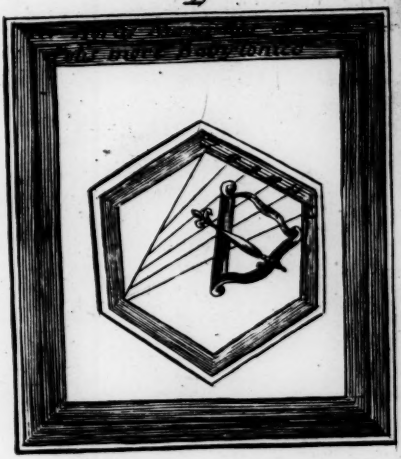
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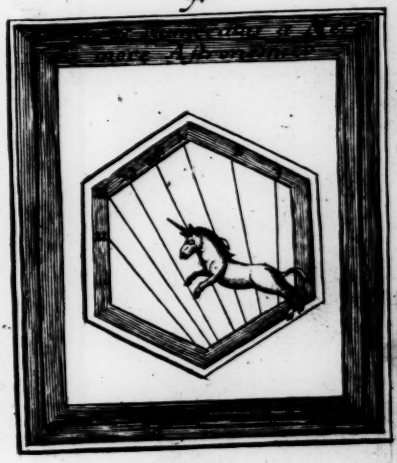
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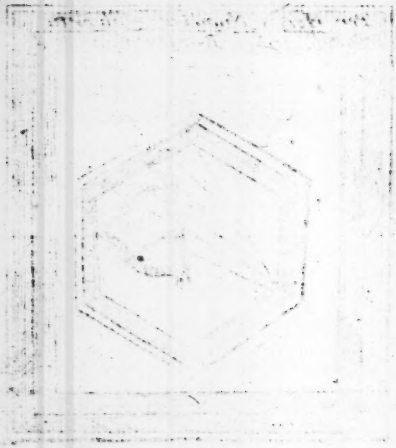


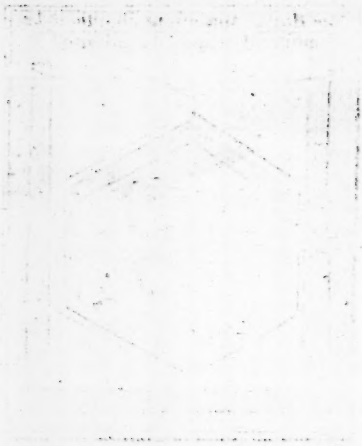
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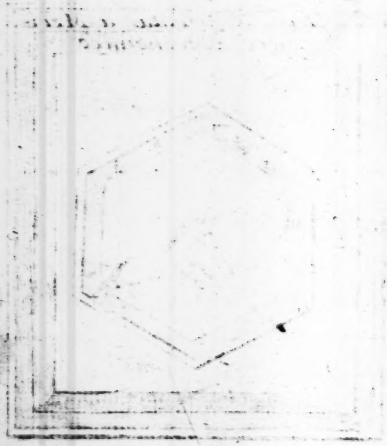


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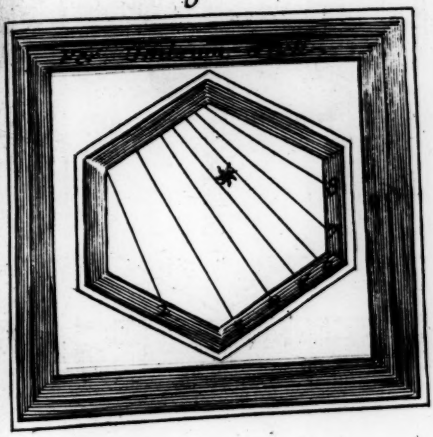








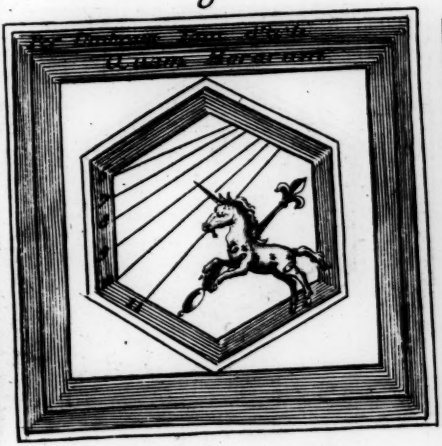
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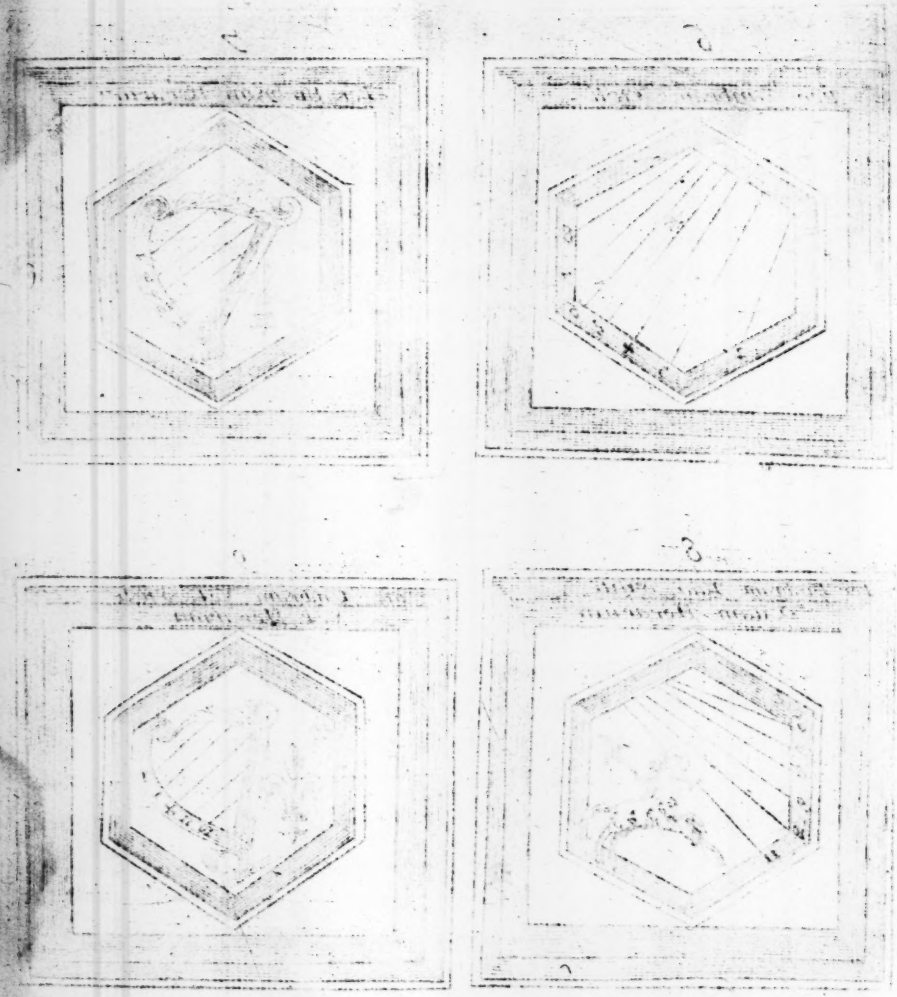


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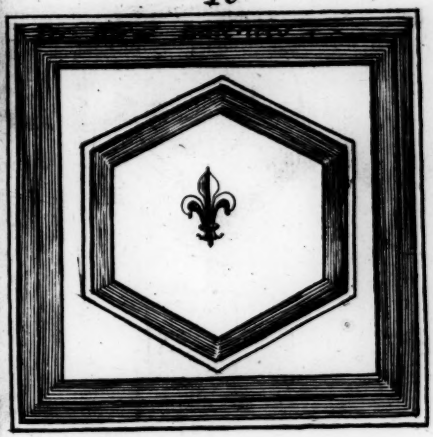


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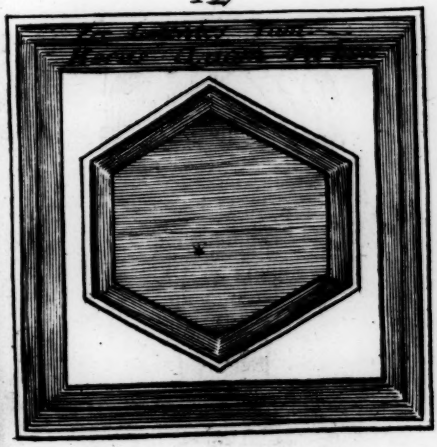
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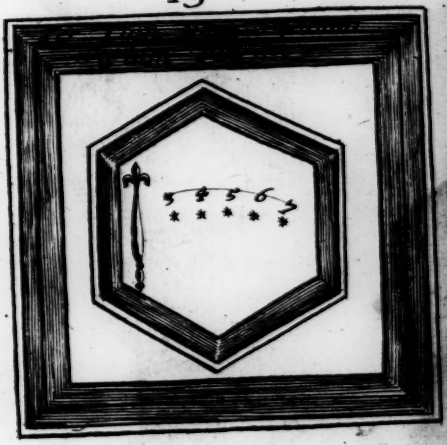
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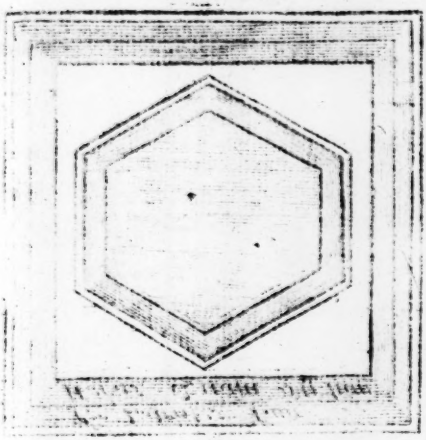


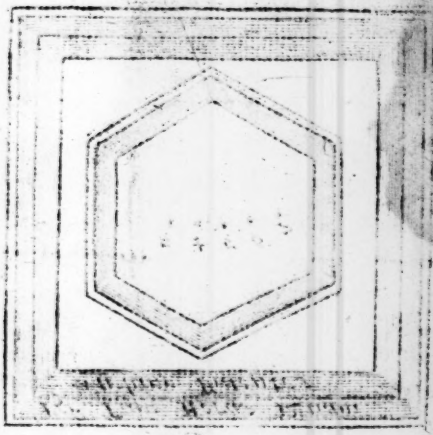
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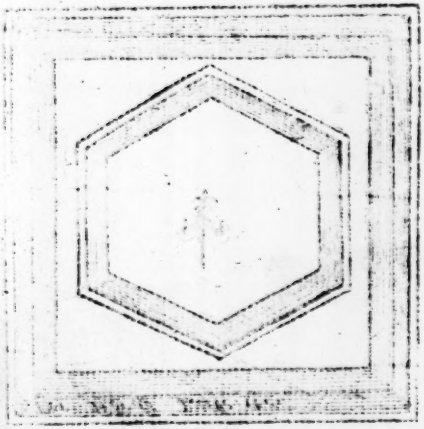


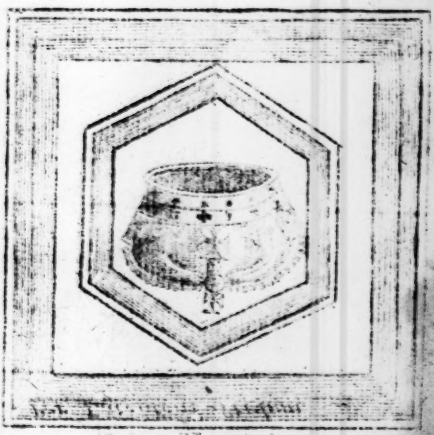
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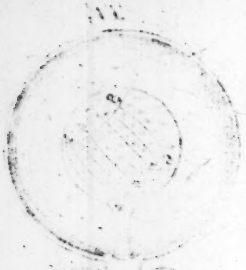


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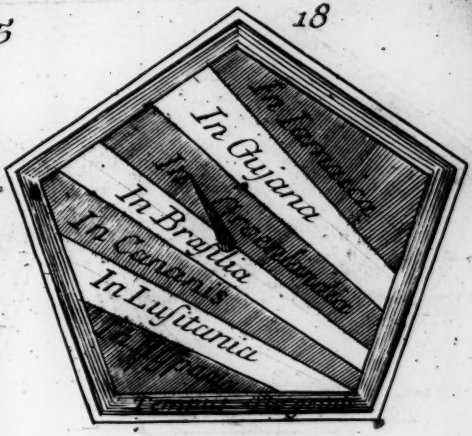




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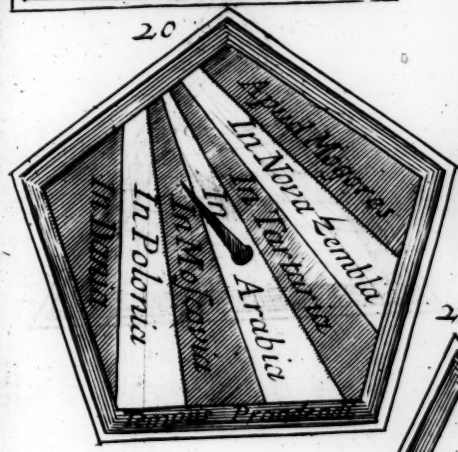
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In Guyana
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In Canaris
In Lusitania

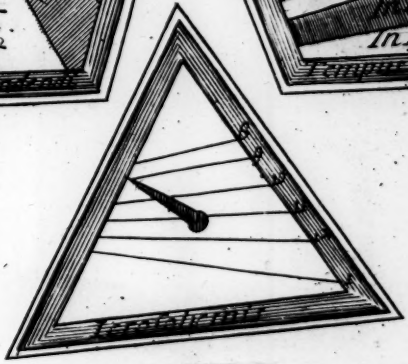
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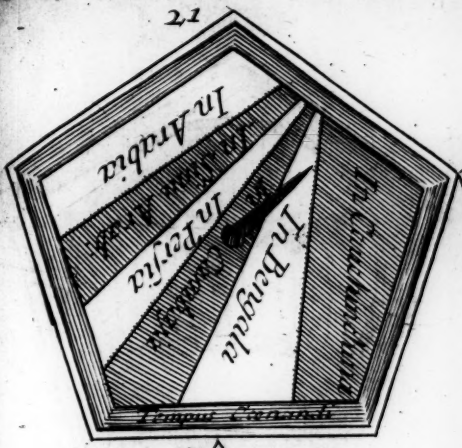

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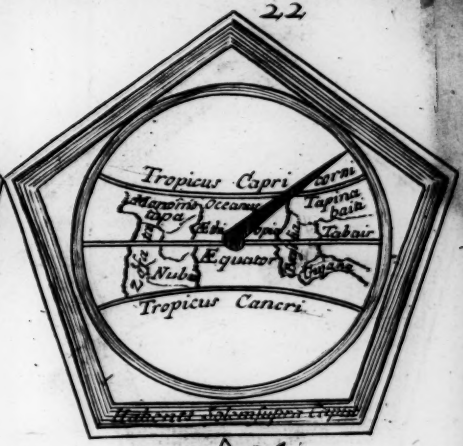
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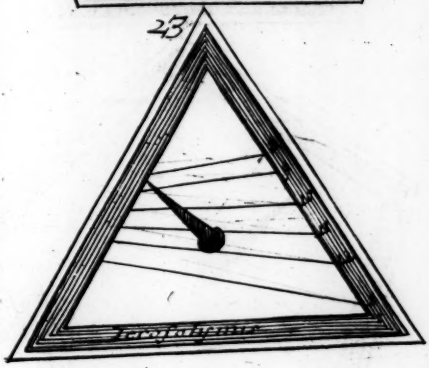

Apud Mogores
In Nova Zembla
In Tartaria
In Arabia
In Moscovia
In Polonia

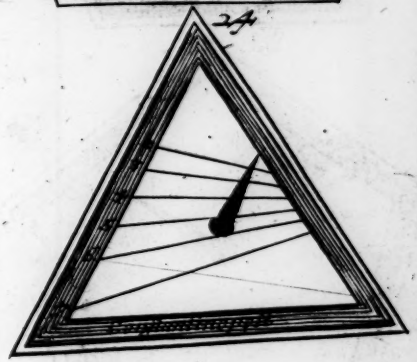
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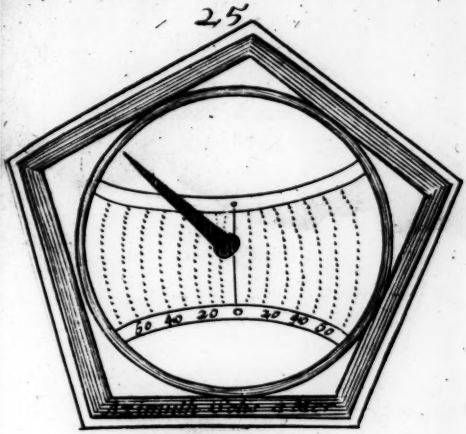

21
In Arabia
In Persia
In Bengala
In Cambaia
Tempus Orandi


22
Tropicus Capri corni
Tapina baia
Tabair
Equator
Nubia
Tropicus Cancri
Habent Solem super Capita

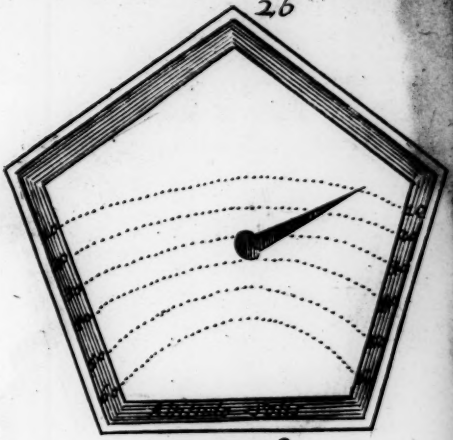

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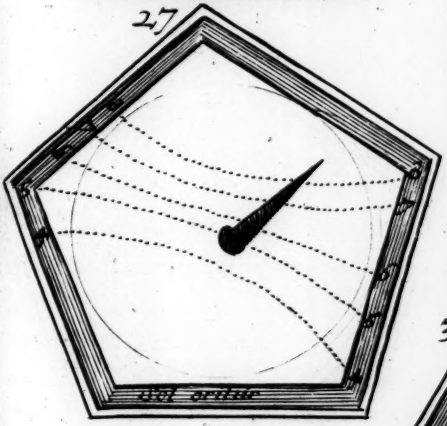
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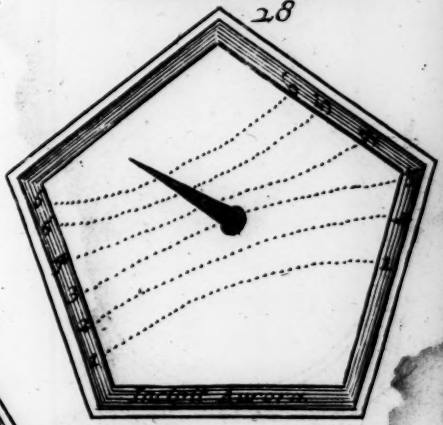
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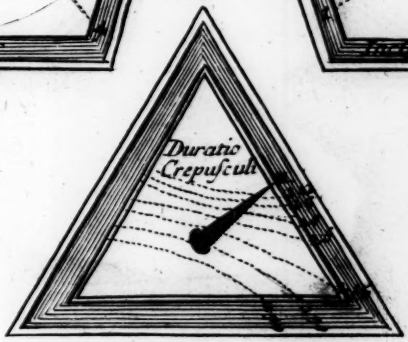
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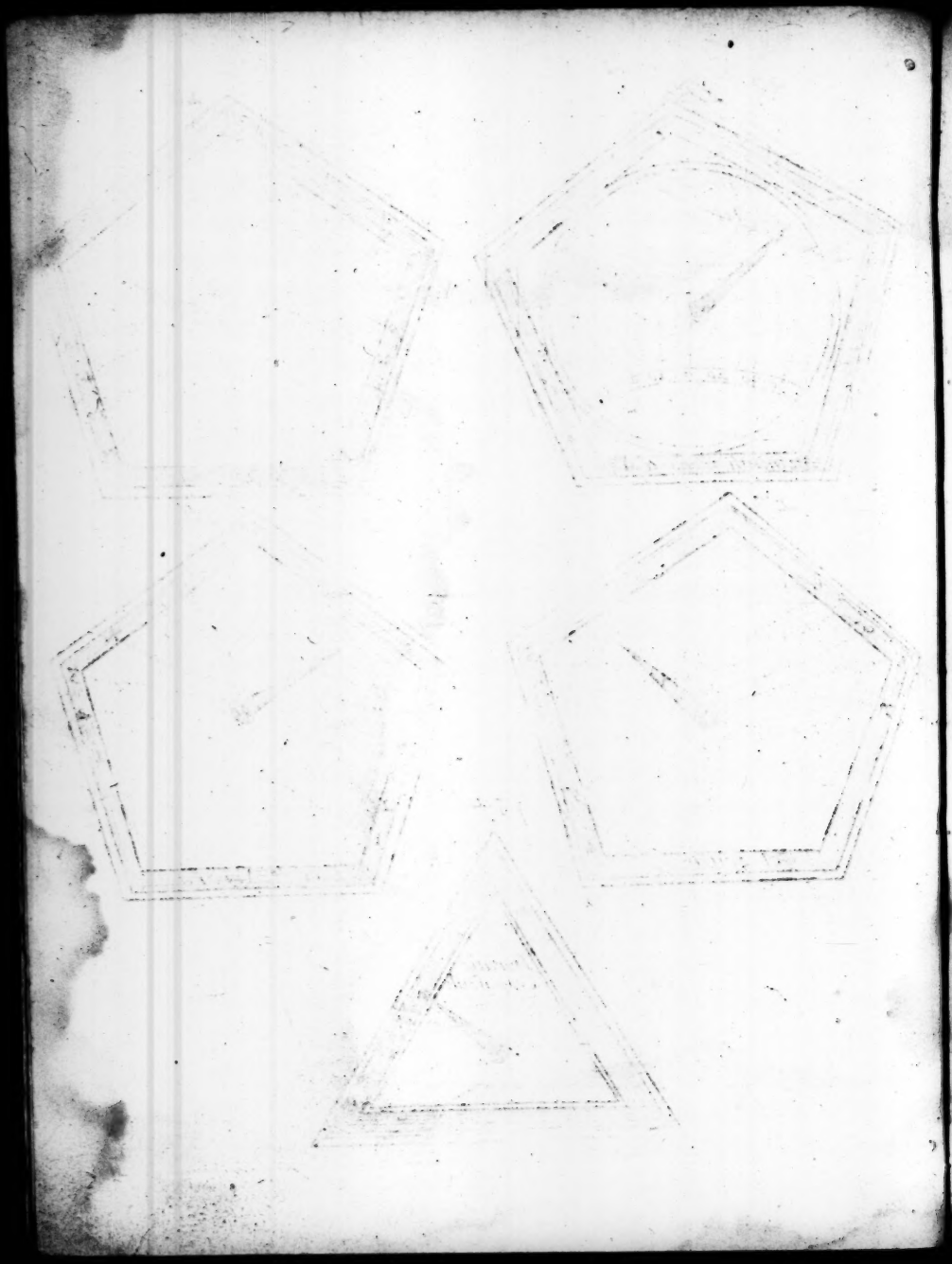


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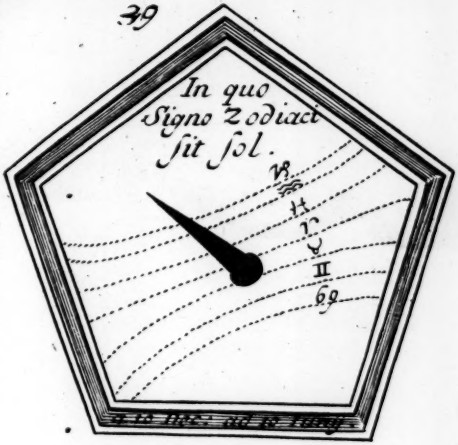


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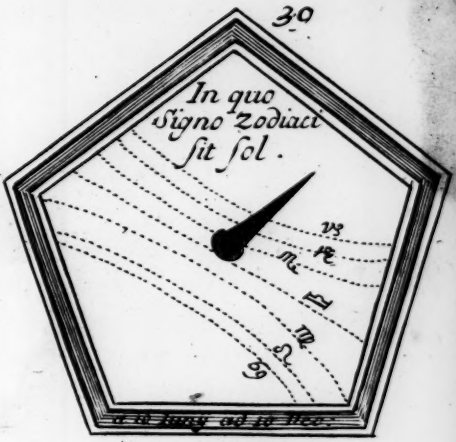




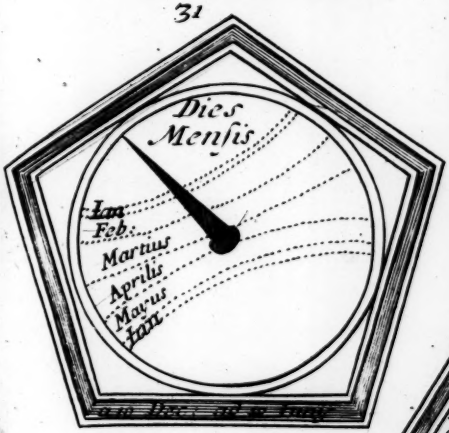
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In quo
Signo Zodiaci
sit Sol.

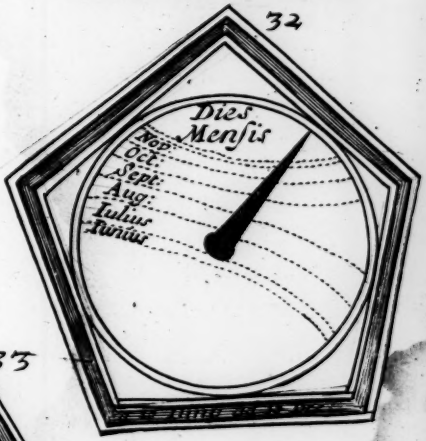
30


In quo
Signo Zodiaci
sit Sol.

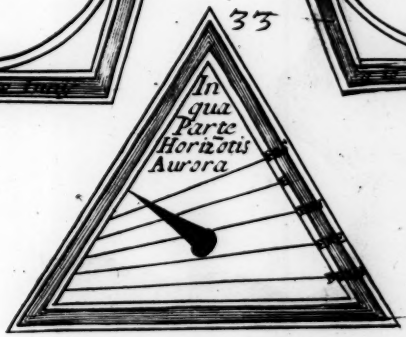
31


Dies
Mensis
Martius
Aprilis
Maius

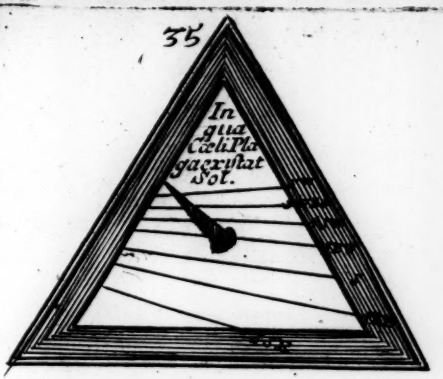
32


Dies
Mensis
Sept.
Aug.
Iulius

33


In
qua
Parte
Horizontis
Aurora

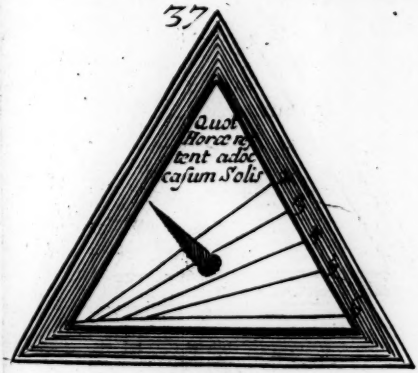
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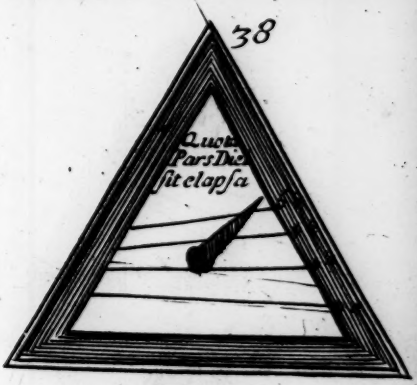
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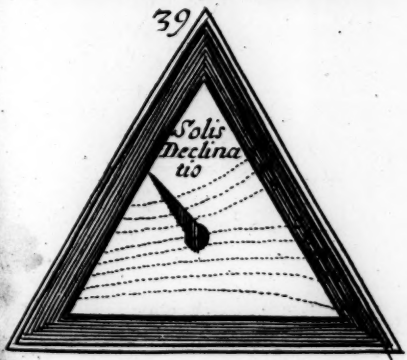
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38



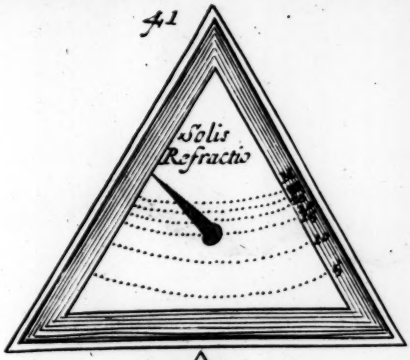
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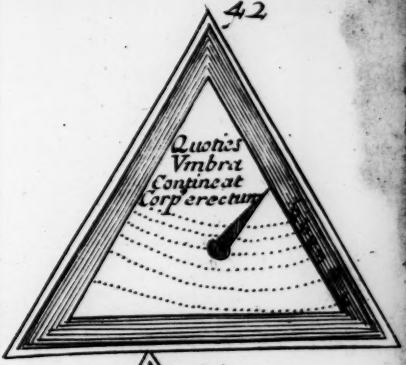
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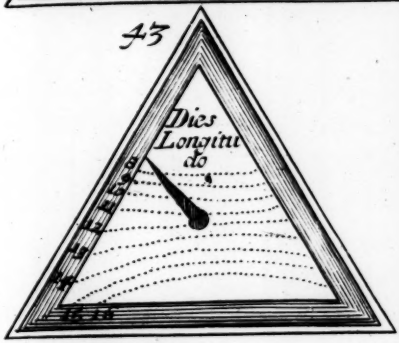
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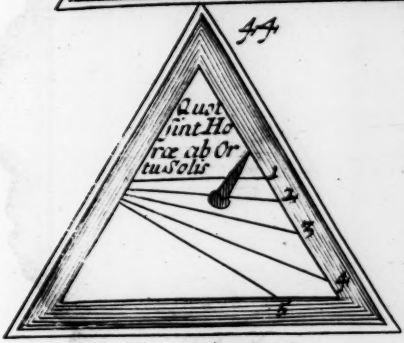
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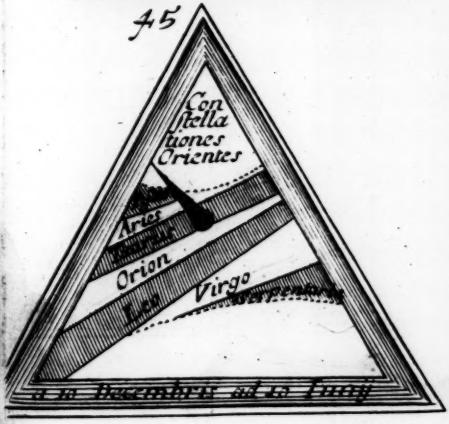
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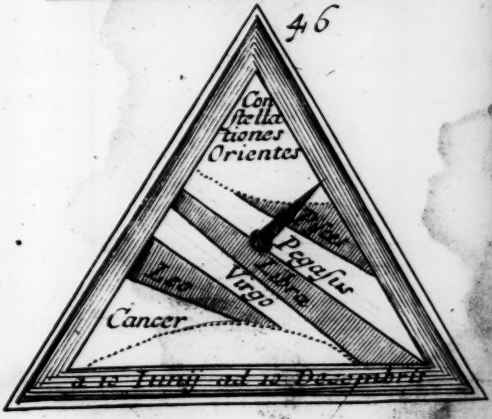
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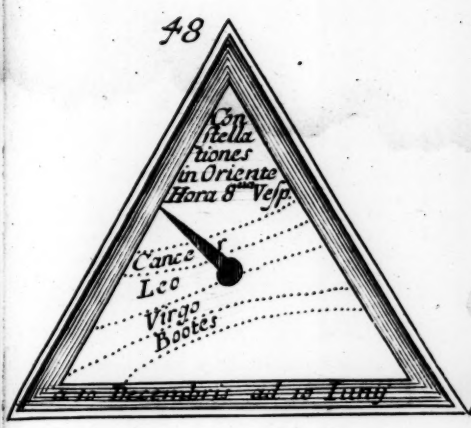
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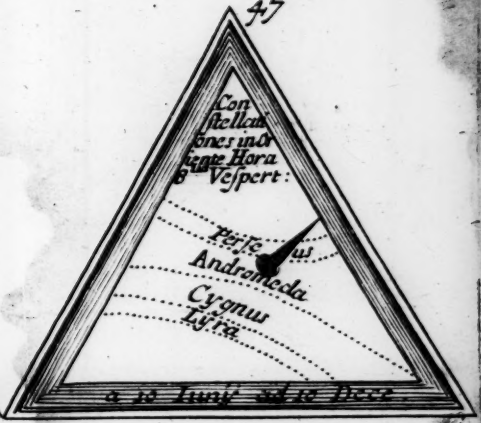
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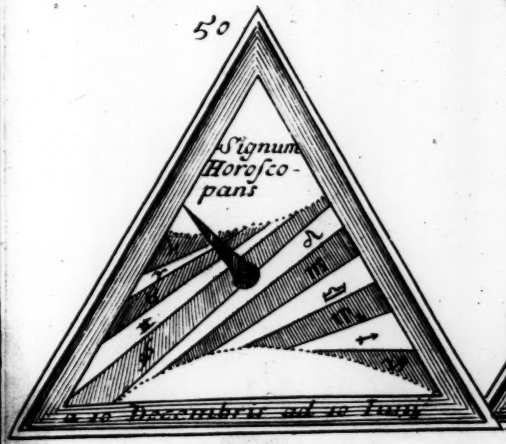
48


Constellationes in Oriente Hora 8va Vesp.
Cancer
Leo
Virgo
Bootes
a 10 Decembris ad 10 Junij

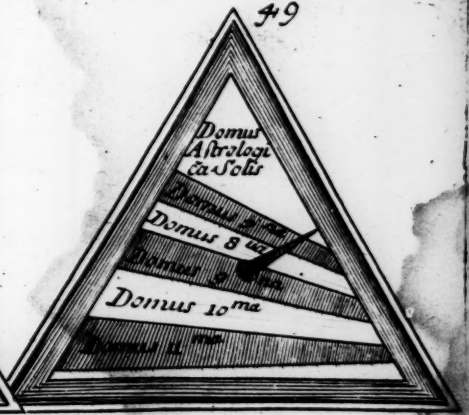
47


Constellationes in dicta Hora 8va Vespert:
Perseus
Andromeda
Cygnus
Lyra
a 10 Junij ad 10 Dece

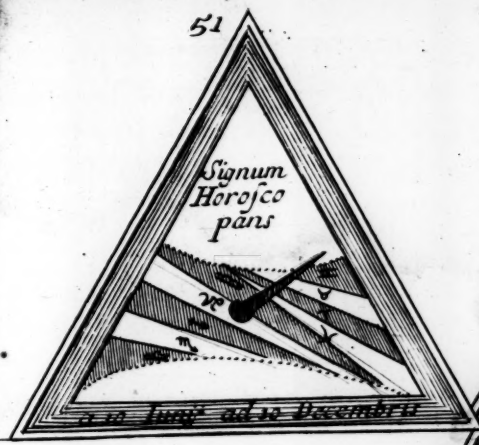
50


Signum Horoscopans
a 10 Decembris ad 10 Junij

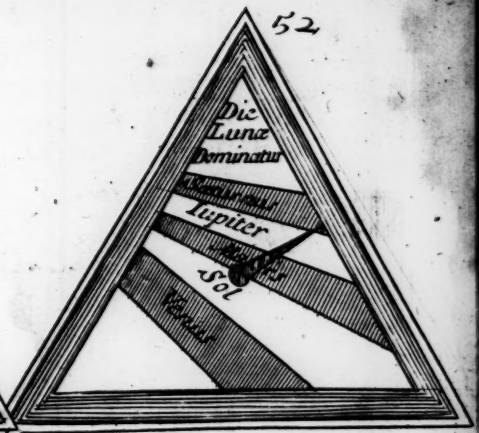
49


Domus Astrologica Solis
Domus 8va
Domus 10ma

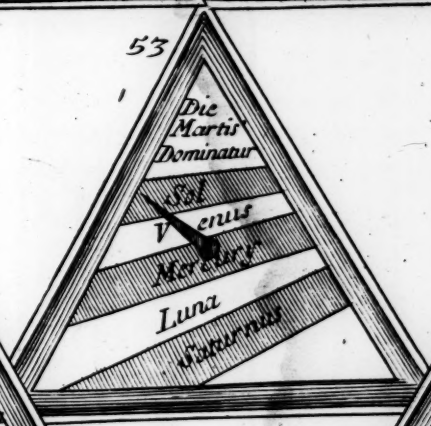
51


Signum
Horosco
pans
a xx Iunij ad xx Decembris

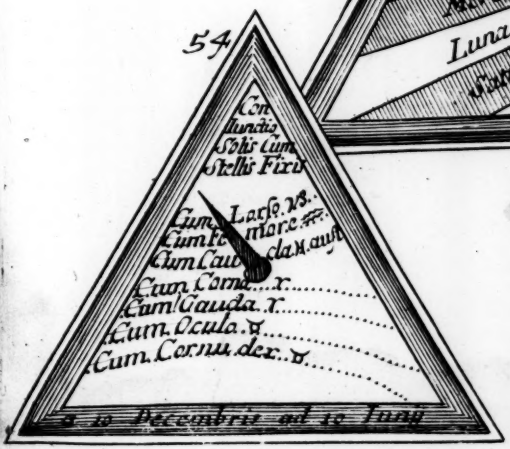
52


Die
Luna
Dominatur
Iupiter
Sol
Venus

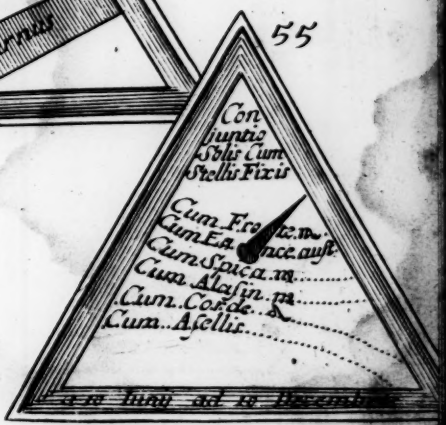
53


Die
Martis
Dominatur
Sol
Venus
Mercurius
Luna
Saturnus

54


Con
iunctio
Solis Cum
Stellis Fixis
Cum Laeua ♎
Cum Fronte ♏
Cum Cauda ♐
Cum Corna ♑
Cum Cauda ♈
Cum Oculo ♉
Cum Cornu dex. ♉
a xx Decembris ad xx Iunij

55


Con
iunctio
Solis Cum
Stellis Fixis
Cum Fronte ♎
Cum Ala sin. ♍
Cum Spica ♍
Cum Ala sin. ♍
Cum Corde ♌
Cum Asellis
a xx Iunij ad xx Decembris

56

Stellæ Orientes Cosmice

Ala Pegasi
Triangulum
Pes sin. ♐
Cornu ♈
Pes sin. Aurigæ
Oculus ♉

a 10 Decemb. ad 10 Iun.

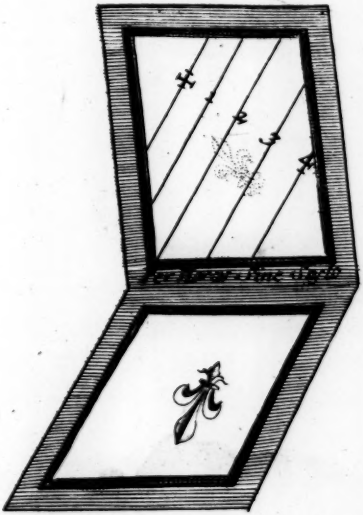
57

Stella Orientes Cosmice

Regulus
Spica ♍
Arcturus ♎
Cauda ♌
Sirius
Canicula

a 10 Iunij ad 10 Decemb.

58



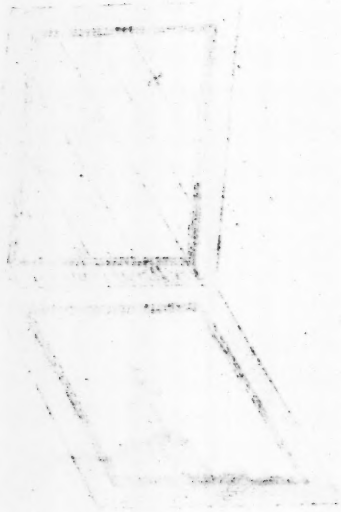
59











60


Per
Stylum
sine
Vmbra

61


Per
Vmbram
sine
Stylo

62


Per
Stylum
&
Vmbra

63


Sine
Stylo Vel
Vmbra









64

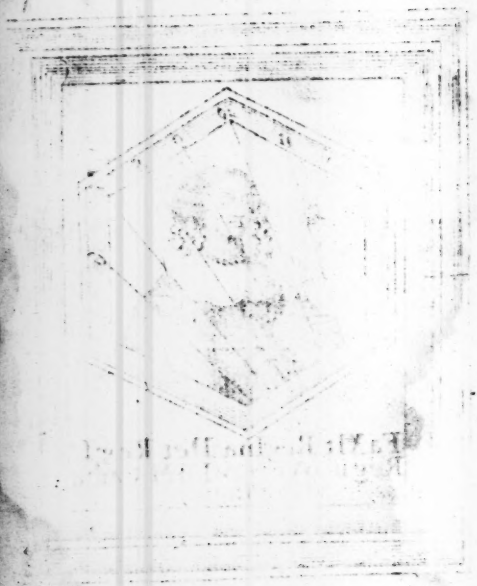


Regnet DIV CaroLVs
IMperetqVe BrItannIs

65



FaXIt ReglnaDet RegI
RegnoqVe proLeM Catha
rIna



66


Per
Horas It
alicus

67


Per
Horas Ba
bylonica

68

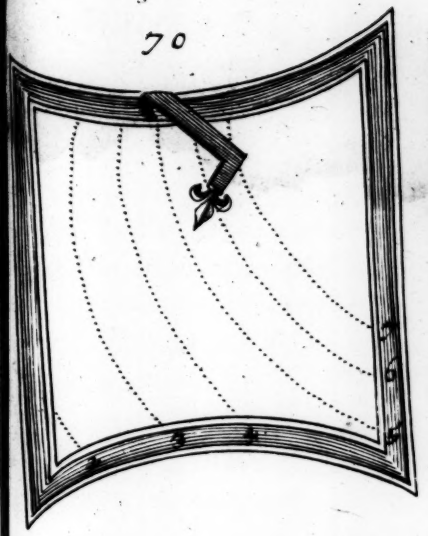

Per
Horas Aſt
ronomicas

69

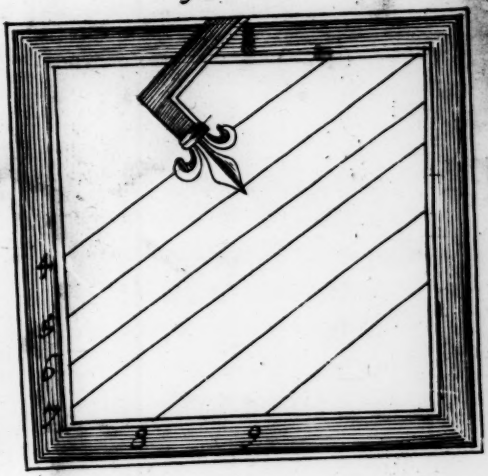

Per
Horas An
tiquas



70



71



72



73

